[redacted]

NAVAIR 01-245FDB-1T

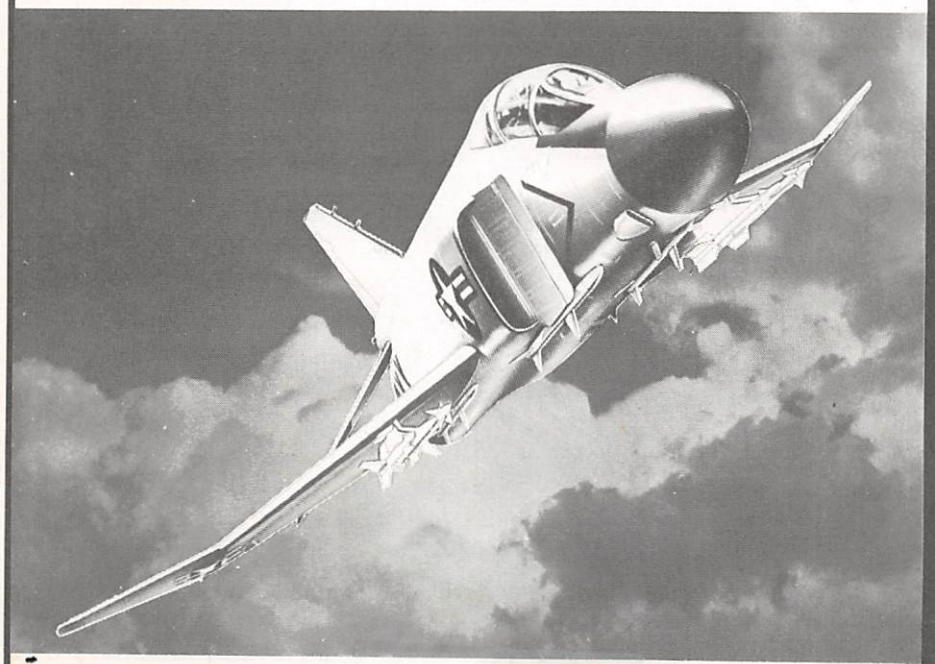
TACTICAL MANUAL

NAVY MODEL F-4B, F-4J, AND F-4N AIRCRAFT (U)

6281

MCDONNELL AIRCRAFT
St. Louis, Mo.

NOw(A)65-0044-f
N00019-70-C-0099



GLOSSARY

I AIR-TO-AIR WARFARE

II CONVENTIONAL AIR-TO-GROUND WARFARE

III AIRCRAFT EMPLOYMENT

IV NUCLEAR AIR-TO-GROUND WARFARE

V ENEMY DEFENSES and FRIENDLY COUNTERMEASURES

APPENDIX A AIRCRAFT LIMITATIONS

APPENDIX B INTELLIGENCE

APPENDIX C QUESTION BANK

ALPHABETICAL INDEX

[redacted]

062576063096

1 SEPTEMBER 1972

This page is UNCLASSIFIED

[redacted]

PROUDMARINEANDWIFE

Reproduction for nonmilitary use of the information or illustrations contained in this publication is not permitted. The policy for military use reproduction is established for the Army in AR 380–5, for the Navy and Marine Corps in OPNAVINST 5510.1B, and for the Air Force in Air Force Regulation 205–1.

LIST OF EFFECTIVE PAGES

Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.

NOTE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line in the outer margin of the page.

Dates of issue for original and changed pages:

Original . . 0. . 1 Sep 72

Total number of pages in this manual is 724 consisting of the following:

Page No.	# Change No.	Page No.	# Change No.	Page No.	# Change No.
Title	0				
A	0				
Flyleaf 1	0				
Flyleaf 2 Blank	0				
i - xxiv	0				
1-1 - 1-108	0				
1-109 Blank	0				
1-110 - 1-242	0				
2-1 - 2-267	0				
2-268 Blank	0				
2-269 - 2-273	0				
2-274 Blank	0				
2-275 - 2-384	0				
3-1 - 3-26	0				
4-1	0				
4-2 Blank	0				
5-1	0				
5-2 Blank	0				
A-1 - A-23	0				
A-24 Blank	0				
A-25	0				
A-26 Blank	0				
B-1	0				
B-2 Blank	0				
C-1 - C-12	0				
Index 1 - Index 22	.				

Zero in this column indicates an original page.

INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 THRU 46	

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE
47	External stores limitations
48	External stores limitations
49	External stores limitations
50	External stores limitations
51	External stores limitations
52	External stores limitations

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

TABLE OF CONTENTS

BIBLIOGRAPHY

GLOSSARY OF TERMS AND ABBREVIATIONS

SECTION I AIR-TO-AIR WARFARE 1-1

PART 1 AIR COMBAT MANEUVERING 1-1
PART 2 RADAR TECHNIQUES 1-120
PART 3 WEAPONS SYSTEM 1-136
PART 4 ESCORT 1-181
PART 5 COMBAT AIR PATROL 1-183
PART 6 INTERCEPT 1-186
PART 7 MISSILE FIRING EXERCISE 1-205
PART 8 ECM/ECCM ..... *

SECTION II CONVENTIONAL AIR-TO-GROUND WARFARE 2-1

PART 1 GENERAL 2-1
PART 2 MISSIONS 2-70
PART 3 DELIVERY MANEUVERS 2-101
PART 4 WEAPON DELIVERY DATA 2-123

SECTION III AIRCRAFT EMPLOYMENT 3-1

PART 1 AIR INTERCEPT CONTROL 3-1
PART 2 EMPLOYMENT CONSIDERATIONS 3-10

SECTION IV NUCLEAR AIR-TO-GROUND WARFARE 4-1*

SECTION V ENEMY DEFENSES AND FRIENDLY COUNTERMEASURES 5-1*

PART 1 ANTI-AIRCRAFT MISSILE THREAT ..... *
PART 2 ANTI-SHIP MISSILE THREAT ..... *
PART 3 ANTI-AIRCRAFT ARTILLERY SYSTEMS ..... *
PART 4 AIRBORNE ELECTRONIC WARFARE EQUIPMENT ..... *
PART 5 MANEUVERS AND FORMATIONS ..... *
PART 6 TACTICAL APPLICATIONS ..... *
PART 7 AIR-TO-AIR ECM EQUIPMENT ..... *

APPENDIX A OPERATING LIMITATIONS A-1

APPENDIX B INTELLIGENCE B-1*

APPENDIX C QUESTION BANK C-1

*REFER TO SECRET SUPPLEMENT NAVAIR 01-245FDB-1T(A)

UNCLASSIFIED

FDB-1T-(4)

PROUDMARINEANDWIFE

BIBLIOGRAPHY

Air Force Systems Command Technical Documentary Report No. APGC-TDR-62-64-35 and ATL-TDR-64-28.
Energy-Maneuverability Theory.

CNO Operations Evaluation Group Study No. 586.
The Prediction of Bandit Tallyho Ranges.

Commander Operational Test and Evaluation Force Ser 00123, 19 September 1968.
Have Doughnut.

CTF 77 Operational Order Ser 0027, 15 May 1967.
Yankee Team Tactics Annex Tango to CTF 77.

Defense Intelligence Agency ST-CS-09-20-69.
Air Launched Missiles (Trends) Eurasian Communist Countries.

Defense Intelligence Agency ST-GR-2-68.
Soviet Air Show 1967.

Defense Intelligence Agency ST-HB-09-2-66-INT.
Aircraft Armament Handbook (Characteristics and Performance) Eurasian Communist Countries.

Defense Intelligence Agency ST-BH-09-5-66-INT.
Aircraft Handbook (Characteristics and Performance) Eurasian Communist Countries.

Fleet Intelligence Center Pacific Ser 00459, 16 February 1968.
Southeast Asia Mig Tactics Handbook.

Foreign Technology Division, Air Force Systems Command, 12 May 1967.
FARMER Weapons System.

Foreign Technology Division, Air Force Systems Command, 18 July 1967.
FRESCO Weapons System.

McDonnell Report B163, 26 March 1965.
Analytical Approach to F-4 Maneuvering in Air-to-Air Combat.

NAVAIR 01-245FD-75 (Series)
Conventional Weapons Loading Checklists

NAVAIR 01-245FDB-1
NATOPS Flight Manual.

NAVAIR 01-245FDB-1A.
NATOPS Flight Manual (supplement).

NAVAIR 01-245FDB-2-7.
Armament Handling and Loft Bomb Release Computer Set AN/AJB-3A.

NAVAIR 01-245FDB-2-7.1.
Multiple Weapon Control System.

NAVAIR 01-245FDB-75.
Conventional Weapons Loading.

NAVAIR 01-245FDD-1.
NATOPS Flight Manual.

NAVAIR 01-245FDD-1A
NATOPS Flight Manual (supplement).

NAVAIR 16-1-536.2
Airborne Tactical Data System, System Operational Manual No. 5, 15 January 1969.

NAVAIR OP 2216.
Aircraft Bombs, Fuzes and Associated Components.

NAVAIR OP 3339.
SNAKEYE I Weapon MK 81

Naval Ordnance Laboratory Corona, Missile Systems Dept. 6, April 1965.
Soviet Block Air-to-Air Warfare Capabilities.

NOTS TP1886 NAVORD Report 5808.
The Sidewinder Pilot Looks at the Maneuvering Target.

NWP 31
Anti-Ship Missile Defense.

Sanders Associates Manual, 28 December 1965.
Employment Manual for DECM in Naval Attack Aircraft.

VF-121, June 1969.
Flying and Fighting the Phantom.

VF-121, June 1969.
F-4 (TOPGUN) Fighter Weapons Course Manual.

VX-4 AEN #4, Letter Ser 0129, 6 November 1964. NEW
Sidewinder AIM-9D.

VX-4 AEN #6, 22 September 1964.
F-4B Operational Evaluation, AIM-7E Partial Opeval.

VX-4 AEN #7, 6 April 1965.
F-4B Operational Evaluation, AN/AAA-4 Infrared Detection Group.

VX-4 AEN #8, 1 November 1965.
F-4B Operational Evaluation (O/V-16) AN/APQ-72 ECCM Evaluation

VX-4 AEN #15, 12 October 1966.
Effectiveness of Air-to-Air Missiles Against Maneuvering Targets.

VX-4 AEN #19, 22 November 1966.
AIM-7 Performance in Maneuvering Target Environment.

VX-4 AEN #20, Letter Ser 0014, 24 July 1967. NEW
Conduct Operational Investigation of Electronic Warfare Equipment in the Air-to-Air Environment.

VX-4 AEN #21, December 1967.
MK 4 Gun Pod.

VX-4 AEN #23, Preliminary Report, 10 May 1968.
AIM-7E Plus Min Rng Investigation.

VX-4 AEN #24, 26 June 1968.
AWG-10 Weapons System Performance.

VX-4 AEN #28, 10 October 1970.
Fighter Effectiveness Against Missiles.

NEW NEW NEW NEW

VX-4 AEN #30, Message 070320Z March 1971
O/V37 Task III, Subject Classified.

VX-4 AEN #31, Letter Ser 058, 11 August 1971.
F-4 Dogfight Optimization Operational Evaluation.

VX-4 AEN #32, Letter Ser 0017, 29 September 1971.
Fleet Operational Investigation of Guided Missile AIM-7E/E-2 (Sparrow) as an Anti-ship Missile.

VX-4 AEN #33, Letter Ser 0023, 8 December 1971.
Fighter Weapons System Operational Evaluation Against Low Altitude, Terminal Phase, Anti-ship Missiles.

VX-4 DOC 12-738, 15 February 1969.
Energy Maneuverability; Differential Energy Rate Diagrams (ΔP_S) Comparing Soviet and U.S. Fighter Aircraft.

VX-5 AEN, 8 March 1965.
F-4B MK 81 Snakeye I.

VX-5, AEN, 8 March 1965.
MK 77 Mod 1, MK 79, Mod 1
Fire Bombs.

VX-5 AEN Ser 071, 7 September 1967.
CBU-24/B Cluster Bomb.

VX-5 AEN Ser 042, 9 May 1968.
Delay Retard Destructor MK 36 Delivery Tactics.

VX-5 AEN Ser 0018, 29 March 1968.
Counter Tactics for Surface-to-Air Weapons.

VX-5 AEN Ser 0020, 5 April 1968.
Destructor MK 36 Delivery Tactics, Change 1, Ser 040, 7 May 1968.

VX-5 AEN, 23 July 1968.
Rockeye II Weapons System.

Weapon Systems Evaluation Group.
WSEG Report #R-123 Vol. I, October 1967.
WSEG Report #116 Vol. IV, April 1968.

Weapon Systems Evaluation Group.
WSEG Report IIT, Vol. I - III.
Air-to-Air Encounters in Southeast Asia

GLOSSARY OF TERMS AND ABBREVIATIONS

AA	Anti-aircraft or automatic acquisition. Automatic acquisition is a method of search in the pulse doppler mode of operation in which the radar system automatically locks on the first target it sees in the clear region.
AAA	Anti-aircraft Artillery
AAC	Aircraft Armament Change
AAM	Air-to-Air Missile
AAW	Anti-Air Warfare
ACI	Airborne Controlled Intercept
ACM	Air-combat-maneuvering
ACQ	Acquisition
ADI	Attitude Director Indicator
ADL	Armament Datum Line
ADVERSE YAW	Yaw away from the intended turn
AEW	Airborne Early Warning
A-G	Air-to-ground
AGC	Automatic Gain Control
AGL	Height Above Ground Level (e.g., Release Height AGL)
AGM (AIR-TO-GROUND MISSILE)	An air launched guided missile for attacking surface targets.
AI	Air Intercept
AIC	Airborne Intercept Controller
AIM	Air launched, intercept-aerial, guided missile
AIMING ERROR	The deviation of the actual aim point from the desired aim point.
AIR BURST	Any burst in the air, but usually having reference to the bursting of a projectile or bomb above ground.
AIRSPEED	The speed of an aircraft relative to its surrounding air mass. The unqualified term air speed can mean any of the following: a. Indicated Airspeed - The airspeed shown by an airspeed indicator. Indicated airspeed is expressed in knots and is abbreviated KIAS. b. Calibrated Airspeed - Indicated airspeed corrected for static source error. Calibrated airspeed is expressed in knots and is abbreviated KCAS. c. True Airspeed - Indicated airspeed corrected for instrument installation error, compressibility error and errors due to variations from standard air density. True airspeed is expressed in knots and is abbreviated KTAS.
AIR-TO-GROUND	Used or occurring between aircraft and the ground, as air-to-ground communication, air-to-ground gunnery, air-to-ground interdiction, air-to-ground rocket, etc.
ALT	Altitude, MSL unless specified AGL.
ALTITUDE LINE	Heavy band of clutter produced by radar sidelobe energy reflections from the earth surface.
AMCS	Airborne Missile Control System.
ANGLE OF ATTACK (AOA)	The angle between the FRL and flight path.
ANGLE OFF	The angle between the longitudinal axis of a defender and the line of sight of an attacker.
ANT	Antenna
ANTENNA TRAIN ANGLE	The angular measurement between interceptor heading and the bearing to target.

AOJ	Acquisition-On-Jam
AREA BOMBING	Bombing of an area target rather than a small or pin-point target.
AREA TARGET	A target consisting of an area rather than a single point.
ARMING	As applied to fuzes, the changing from a safe condition to a state of readiness for initiation.
ARMING DELAY	The time interval between the instant a bomb is launched and the instant the fuze becomes armed.
ARMING DEVICE	Device for arming a fuze under controlled conditions.
ARMING WIRE	A wire inserted in a weapon fuzing system which, when removed, will allow arming of the weapon fuze(s).
ASE	Allowable Steering Error
ASM	Air-to-Surface/Anti-Ship Missile.
ASPECT ANGLE	The angle between the bogey's flight path and the LOS to the interceptor.
ASPECT RATIO	Wing span squared divided by surface area.
ASRT	Air Support Radar Team. (Marine) A highly mobile unit of the Marine Air Support Squadron (MASS) equipped with a radar course directing control center for control of all-weather day/night close air support operations.
ATA	Antenna Train Angle.
ATTACK HEADING	A heading given the interceptor during the attack phase of the intercept.
AUX	Auxiliary
AW	Automatic Weapons
AZ	Azimuth
BANDIT	Aircraft identified as an enemy
BANG BANG CONTROL	A guidance control system wherein the corrective control applied to the missile is always applied to the full extent of the servo motion.
BARCAP	Barrier Combat Air Patrol
BDHI	Bearing Distance Heading Indicator
BDU	Bomb Dummy Unit
BEAM INTERCEPT	An intercept in which the track crossing angle at missile launch is between 60° and 120°.
BIRDIES	Spurious signals on Pulse Doppler display.
BIT	Built-In-Test
BLC	Boundary Layer Control
BLU	Bomb Live Unit
BOGEY	Unknown air target. In discussing ACM, the terms bogey and bandit are interchangeable.
BOMB DAMAGE ASSESSMENT (BDA)	A judgement on the extent of a bomb damage, either physical or economic; the procedure involved in making this judgement.
BOMB RELEASE POINT	The point in space at which bombs must be released to reach the desired point of impact.
BOMBING ERRORS	Errors which cause bombs to miss the desired mean point of impact. These include aiming errors, release errors, aircraft system errors and ballistic dispersion.
BREAK	A command to instantly execute, or the execution of, a maximum rate of turn.
BST	Boresight
BUSTER	Full Military Power
CAP	Combat Air Patrol
CARDIV FORCE	Carrier Division Task Force

CAS	Calibrated Airspeed
CAS	Close Air Support. Air action against hostile targets in such proximity to friendly forces as to require detailed integration of each mission with the fire and movement of those forces. Close air support requires all ordnance to be delivered on target with a high degree of accuracy.
CATF	Commander Amphibious Task Force. (Navy) Responsible for the conduct of the amphibious operation.
CBU	Cluster Bomb Unit
CCA	Carrier Controlled Approach
CCI	Carrier Controlled Intercept
CCM	Counter-Countermeasures
CEP	Circular error probability. An indication of the accuracy of a missile or projectile which is used as a factor in determining probable damage to a target. It is the radius of a circle within which 50 percent of the missiles or projectiles are expected to fall.
CHARGE, SHAPED (SC)	An explosive charge with a shaped cavity which is lined with a thin metal, usually copper. On detonation, the metal is formed into a long, high speed jet which has considerable armor penetration capabilities.
CHIRP	A special pulse expansion compression technique in which a wide frequency-modulated pulse is transmitted and the received pulse is compressed.
C_L	Coefficient of lift
CIC	Combat Information Center. (Navy) A subordinate operational component of the air control system for control and direction of all defensive air operations.
CM	Countermeasures
COLLISION COURSE	A course that will maintain a constant bearing decreasing range solution.
CONLABS	Conventional Low Altitude Bombing System. Combining the conventional and nuclear release system to ripple - loft GP bombs.
COURSE	Intended flight path projected to the surface.
CW	Carrier Wave or Contiuous Wave
DAS	Deep (formerly Direct) Air Support. Air action conducted against hostile targets such distance from friendly forces that detailed integration of each air mission with fire and movement of friendly forces is not required.
DASC	Direct Air Support Center. (Marine) A subordinate operational component of the Marine air control system designed for control and direction of close air support and other direct air support operations.
DECM	Defensive Electronic Countermeasures.
DEFLECTION ERROR	In bombing, the distance between the point of impact (single bomb) or between the mean point of impact (salvo) and the desired point of impact measured at right angles from the line of the aircraft approach.
DELIVERY ERROR	Errors associated with the delivery of weapons which cause the weapons to miss the desired mean point of impact. Delivery errors include aiming errors, release errors and aircraft system errors. Ballistic dispersion is excluded.
DELTA H	Difference in bogey and interceptor altitude.
DEP	Deflection Error Probable

DF	Direction Finding
DFC	Dogfight Computer
DGD	Degrade
NEW DIHEDRAL EFFECT	Force causing the aircraft to roll in same direction as rudder induced yaw.
DLI	Deck Launched Interceptor
DOWN RANGE TRAVEL	The horizontal distance the weapon travels from release to impact.
DSA	Doppler Spectrum Analyzer
DUCTING	Trapping of electronic pulses between atmospheric layers and/or the surface.
DVST	Direct View Storage Tube
EARLY SIGHT PICTURE	When the pipper arrives on target prior to planned release conditions.
ECCM	Electronic Counter-Countermeasures
ECLIPSING	Target masking in high - PRF systems
ECM	Electronic Countermeasures
EFFECTIVE RANGE	The maximum distance at which a weapon may be expected to inflict casualties or damage.
EMCON	Electromagnetic Radiation Control
EPU	Electric Power Unit
ERROR SENSITIVITY	The miss distance that can be expected when one of the pre-planned delivery conditions is not achieved. The sensitivity of a given delivery parameter to produce an impact error.
EW	Early Warning
FAC	Forward Air Controller. (Marine) An officer (aviator/NFO) member of a tactical air control party who controls close air support missions from a forward observation post on the ground.
FAC(A)	Forward Air Coordinator (Airborne). (Navy/Marine) An officer (aviator) who coordinates, from an airplane (less than 400 Kts), the action of combat aircraft engaged in air support operations. The FAC(A) provides airborne control, target marking, and coordinates the efforts of the attacking aircraft in a low threat area (some AAA and sporadic small arms fire).
FADE AREA	An altitude/range band wherein airborne targets are not discernible.
FIREBOMB	A light cased bomb filled with a thickened aviation fuel which bursts on impact and spreads burning fuel over an area. It is primarily an anti-personnel weapon.
FM	Frequency modulation
FORWARD-QUARTER INTERCEPT	An intercept in which the track crossing angle at missile launch is between 120° and 150°.
FR	Frame
FREEFALL	Unretarded bomb.
FRL	Fuselage Reference Line. A fixed reference line parallel to the longitudinal axis of the aircraft.
FSCC	Fire Support Coordination Center. (Marine) The agency through which the amphibious troop commander plans and coordinates the integration of supporting arms to best support the troop scheme of maneuver.
FUZING RANGE	The maximum distance from a target at which a proximity fuze can be expected to function.
GATE	Maximum Power
GCG	Guidance and Control Group
GCI	Ground Controlled Intercept

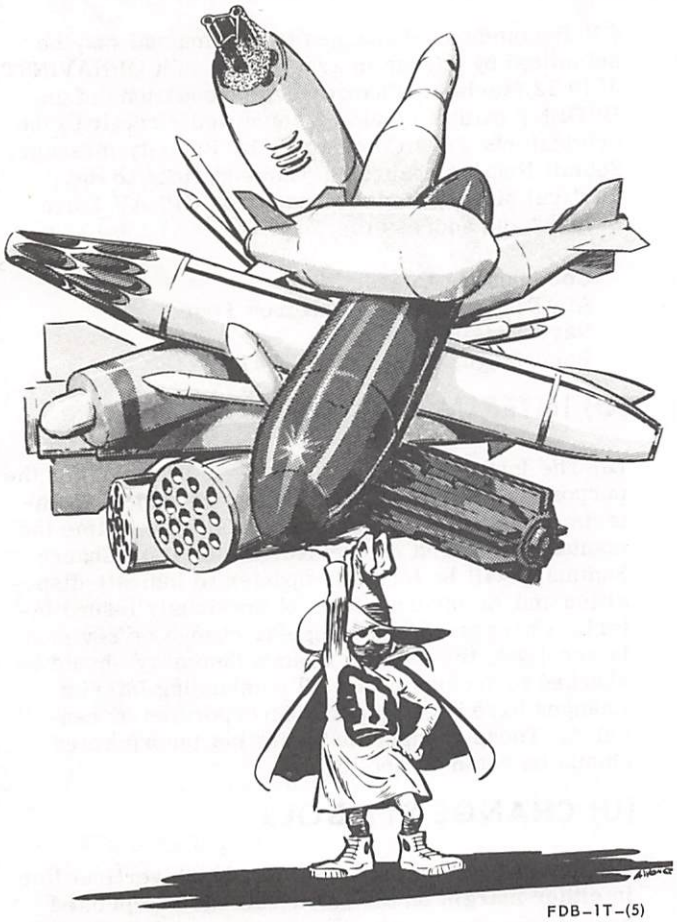
GS	Ground Speed
GUIDANCE TIME	The total time that a missile is able to guide itself.
HARP ANGLE	The approximate harp angle is the sum of the dive angle and the sight angle.
HE	High Explosive
HEAD-ON INTERCEPT	An intercept in which the track crossing angle at missile launch is between 150° and 180°.
HEI-T	High explosive incendiary with tracer.
HE-T	High explosive with tracer.
HOJ	Home-On-Jam
HPU	Hydraulic Power Unit
ΔH	Differential Altitude
HSI	Horizontal Situation Indicator
ID	Identification
IF	Intermediate Frequency
IFF	Identification Friend or Foe
IFR	Instrument Flight Rules
IMN	Indicated Mach Number
INITIAL POINT	A visual reference point in the vicinity of the target.
INTERVALOMETER	An electrical device used in bombing to drop a number of bombs at a constant predetermined time interval between bombs.
IP	Initial Point
IR	Infrared
IRBM	Intermediate Range Ballistic Missile
IRCM	Infrared Countermeasures
IRON HAND	Anti-radiation mission.
JAT	Jam Angle Track
JET	Jam Exceeds Threshold
JETCONLABS	Jet Aircraft, Conventional Weapons, Low Altitude Bombing System
JINKING	Continuous random change of heading and altitude along a base course.
JUDY	Call when aircrew takes control of the intercept.
KCAS	Knots Calibrated Airspeed
KIAS	Knots Indicated Airspeed
KLICK	Kilometer
KPA	Klystron Power Amplifier
KTAS	Knots True Airspeed
LABS	Low Altitude Bombing System
LAE	Lead Angle Error
LATE SIGHT PICTURE	Pipper arrives on target after passing release point.
LAU	Launcher Unit
LAUNCHER ANGLE	The angle between the launcher line of a rocket and the ADL.
LAUNCHER LINE	The longitudinal axis of a rocket when attached to the launcher.
LAUNCHING FACTOR (f)	Represents the initial jump of the rocket at launch, as the rocket turns into the line of flight. As the velocity of the airplane is increased, the f-factor approaches 1.0.
L/D	Lift Over Drag
LDGP	Low Drag General Purpose (Bomb)
LEAD COLLISION COURSE	A straight line course that points the fighter at the projected impact point for the bogey and the air launched weapon.
LEAD PURSUIT COURSE	A curvilinear flight path in which the interceptor armament is continuously directed ahead of the target by the amount required to secure a hit.

LFC	Landing Force Commander, (Marine) Responsible for the conduct of operations ashore.
LINE OF SIGHT (LOS)	The line from the eye to the aiming point, through the optical sight.
LINER	Maximum range airspeed
M	Air Force/Army designation for model.
MAG	Marine Aircraft Group.
MAXIMUM RANGE (WEAPONS)	When used in the sense of maximum effective range, it means the maximum distance at which a weapon may be expected to deliver its destructive charge with an accuracy specified to inflict prescribed damage.
MBC	Main beam clutter
MCP	Missile Control Panel
MDS	Minimum discernible Signal
MER	Multiple Ejector Rack
MEAN POINT OF IMPACT	Distance between the actual mean point of impact and the desired mean point of impact.
MEM	Memory
MIL	A unit of angular measurement which subtends one foot at 1000 feet.
MISSION PROFILE	A pictorial presentation of the flight path of the attack airplane as seen in the vertical plane.
MK	Mark, Navy Designation for model.
MN	Mach number
MOD	Navy designation for modification.
MPI	Mean Point of Impact
MSL	Mean Sea Level
NM	Nautical Miles
OCE	Officer Conducting the Exercise
OFFSET POINT	The point in space offset from the target's flight path toward which an interceptor is vectored and from which the final or a preliminary turn to attack heading is made.
OPERATIONAL ALTITUDE	The range of altitudes within which a system will function properly.
OVERSHOOT	A turn in which the radius of turn is larger than desired, resulting in lateral separation from the desired position.
PADLOCK	Radio call meaning I am visually locked on the bogey and cannot afford to look away.
PD	Pulse Doppler
P_h	Hit Probability
P_k	Kill Probability, the probability of damaging a target to the desired extent.
PLM	Pilot Lockon Modification
PLMS	Power Level Mode Switching
POINT TARGET	A target, such as a pillbox or tank, whose dimensions are relatively small.
POP UP	A rapid climb from a lower altitude to an entry position.
POUNCER	Offensive tactic where interceptor remains secluded and aircrew is on lookout for enemy aircraft to pursue.
PPI	Plan Position Indicator
P-R	Pause-to-range
PRF	Pulse Repetition Frequency
P_s	Specific Excess Power
PSEUDO DOPPLER	A 52.5 kHz signal for tuning the missile receivers.

PULL-UP POINT	The point at which a pilot must start to climb from a low level approach in order to execute the attack.
PLS	Pulse
PRS	Press
PURSUIT COURSE	The aircraft is being flown on a pursuit course if its weapons are always pointed directly at the target.
Q	Aerodynamic Pressure
QUIESCENT DOPPLER	A 40 kHz doppler signal substituted for simulated doppler before radar lockon.
R_a	Missile Aerodynamic Range
RAD CAP	Radar Picket Combat Air Patrol
RANGE CONSTANTS	Range constants are the fuel, distance and time (F/D/T) required for the following segments; (1) Takeoff and acceleration. (2) climb, (3) descent, (4) attack and escape.
RANGE SPECIFICS	Range specifics are fuel consumption quantities for cruise segments. They a are presented in pounds of fuel per mile.
RBL	Radar Boresight Line. Two degrees below the FRL (35 mils).
RCVR	Receiver
RDX	An explosive containing a crystalline substance (cyclonite) which is sensitive to shock.
REAR-QUARTER INTERCEPT	An intercept in which the track crossing angle at missile launch is between 30° and 60°.
RELEASE ALTITUDE	Altitude of an aircraft above the ground at the time of release of bombs, rockets, missiles, tow targets, etc.
RELEASE HEIGHT	Release Altitude AGL (used interchangeably).
REP	Range Error Probable
RESCAP	Rescue Combat Air Patrol
RF	Radio Frequency
R_{max}	Maximum Firing Range
R_{mid}	Center of Firing Envelope
R_{min}	Minimum Firing Range
RSOJ	Range Substitute on Jam
S-A	Safe and Arming Device
SACC	Supporting Arms Coordination Center. (Navy) A single location on board an amphibious task force flagship in which communication facilities and personnel for the coordination of fire support of artillery air, and naval gunfire are centralized. This is the counterpart of the FSCC used by the landing force.
SALVO	A group of several bombs or rocket missiles which were released or launched simultaneously (with no intentional spacing in range).
SAM	Surface-to-Air Missile
SAR	Search and Rescue
SAUNTER	Maximum Endurance Airspeed
SCISSORS	A defensive maneuver in which a series of turns and reversals is executed in an attempt to achieve offensive potential.
SDW	Sidewinder
SEAM	Sidewinder Expanded Acquisition Mode
SHORT PULSE	Refers to 0.65 microsecond pulse width utilized in AN/APG-59 radar at short ranges for improved resolution. NEW
SIGHT ANGLE	The angle between the zero mil sight line and the line of sight.
SIF	Selective Identification Feature

SIM DOPP	Simulated Doppler, a frequency generated from closing velocity to simulate actual target doppler.
SKIP BOMBING	A method of aerial bombing in which the bomb is released from such a low altitude that it ricochets off the surface of the water or ground and strikes the target at or above water level or ground level.
SLANT RANGE	The distance between a weapon and the target at the instant of firing or release.
SLC	Side Lobe Clutter
SPW III	Sparrow Missile
SS	Single-scan
STAE	Second-Time Around Echo
STALO	Stabilized Local Oscillator
STC	Sensitivity Time Control
STICK	A number of bombs released from an aircraft so as to impact in train.
SUU (abbr)	Suspension Unit Universal. 1. A device for carrying and ejecting a large number of bomblets from a high speed aircraft. 2. A gun pod.
SW	Sidewinder
TAC	Tactical Air Commander. (Navy/Marine) Coordinates planning of all phases of air participation of the amphibious operation.
TAC(A)	Tactical Air Coordinator. (AIRBORNE). (Navy/Marine) An officer (aviator) who coordinates, from an airplane (400 Kts plus), the action of combat aircraft engaged in air support operations. The TAC(A) provides airborne control, target markings, and coordinates the efforts of the attacking aircraft in a high threat area (SAM/AAA/intense small arms fire).
TACC	Tactical Air Control Center. (Navy/Marine) The principal air operations installation from which all aircraft and air control functions of tactical air operations in an objective area are coordinated.
TACP	Tactical Air Control Party. (Marine) A troop facility for the integration, coordination, and employment of air support for the ground unit commander.
TACRON	Tactical Air Control Squadron. (Navy) A subordinate administrative and tactical element of a Navy tactical air control group. It provides the control facilities for the ship-based tactical air control center or the ship-based tactical air direction center.
TADC	Tactical Air Direction Center. (Navy/Marine) A subordinate air operations installation from which all aircraft and air control functions of tactical air operations in an assigned portion of an objective area are coordinated.
TALLYHO	Visual contact with a target.
TAOC	Tactical Air Operations Center. (Marine) A subordinate element of the Marine air control system which is responsible for direction of anti-air warfare operations in its area of responsibility (compares with Navy CIC).
TAOR	Tactical Area of Responsibility.
TARCAP	Target Combat Air Patrol
TARGET ELEVATION	The elevation of the target base above mean sea level.
TAS	True Airspeed
TCA	Track Crossing Angle
TDD	Target Detecting Device
TER	Triple Ejector Rack

TERR	Terrain
TRACK	Actual flight path projected to the surface.
TRACK CROSSING ANGLE	The angular difference between interceptor and target headings.
TRAJECTORY DROP	The effect of gravity and drag on the weapon after release. Trajectory drop is the angle in mils between the line of sight to the impact point and the aircraft flight path for bombs; for rockets the launcher line is used.
TURBINE MODULATION	Harmonics of target doppler frequency appearing on the PD display as a series of false velocity targets at the same azimuth and elevation as a real target.
TWT	Traveling Wave Tube
TX	Transmit
V_c	Closing Velocity
VCMR	Variable Charge to Mass Ratio. Usually associated with the MK 63 Anti-Personnel Zuni warhead.
Vf	Velocity of Interceptor
VFO	Variable Frequency Oscillator
VFR	Visual Flight Rules
VI	Visual Identification
VID	Visual Identification
V_m	Velocity of the missile
V_t	Velocity of the Target
VTAS	Visual Target Acquisition Set.
YO-YO	An offensive tactic in which an attacker maneuvers through both the vertical and horizontal planes to prevent an overshoot in the plane of the defenders turn, or to decrease lateral separation. A yo-yo may also be used to maneuver in close proximity to a ground target.
XMTR	Transmitter
ZSL	Zero Sight Line. The pipper is on the ZSL when the reticle depression knob is on zero. ZSL is parallel with the FRL.



FDB-1T-(5)

(U) SCOPE

(U) The F-4B/N and F-4J Tactical Manual, prepared under the direction of Commander Operational Test and Evaluation Force and approved by the Chief of Naval Operations, contains the latest information regarding the tactical employment of the F-4B/N and F-4J aircraft and their various combat missions. Information contained in this manual has been derived from many sources to provide one main source for procedures, techniques, and data to enable the pilot/RIO to most effectively employ the aircraft and its weapons systems in combat. The NATOPS Flight Manual standardizes ground and flight training procedures and contains the information to thoroughly acquaint the pilot/RIO with the aircraft. Information in this manual is primarily oriented to Tactical Employment of the aircraft which presupposes a thorough knowledge of the NATOPS Flight Manual. A description of the Aircraft Tactical Manual program is contained in OPNAVINST 3510.12 (series).

(U) ARRANGEMENT

(U) The Tactical Manual consists of the Confidential Manual and a Secret Supplement. Each has the same format. There are eight major sections.

(U) SECTION I, AIR-TO-AIR WARFARE, is subdivided into 8 parts. Part 1 presents fighter tactics in a non-friendly environment; part 2 describes radar techniques which will ensure optimum radar performance, and tactical employment of the visual target acquisition set and AN/APX-76A interrogator set; part 3 describes the capabilities and limitations of the missile weapons system; part 4 describes Strike Force escort tactics; part 5 presents Combat Air Patrol information including briefing requirements, procedures enroute to, and on the CAP station, standard CAP patterns, and specialized CAP patterns; part 6 presents air-to-air intercept procedures; part 7 describes procedures for missile firing exercises; part 8 (Secret) discusses the application of ECM/ECCM in the air-to-air environment.

(U) SECTION II, CONVENTIONAL AIR-TO-GROUND WARFARE, is subdivided into 4 parts: Part 1 describes general information for weapons delivery; part 2 describes the F-4B/N and F-4J weapons delivery missions and the tactics best suited for the successful accomplishment of these missions; part 3 presents conventional weapons delivery maneuvers and the factors to be considered in the selection of manuever to be used; part 4 presents the weapons delivery data necessary for the accomplishment of the conventional air-to-ground weapons delivery mission.

(U) SECTION III, AIRCRAFT EMPLOYMENT, is subdivided into 2 parts: Part 1 describes the different phases and techniques of air intercept control; part 2 presents the commander a yardstick to use in determining the best ways of employing the F-4B/N and F-4J weapon systems to accomplish his objectives and provide squadron aircrews with a firmer understanding of the important tactical parameters of task force defense.

(U) SECTION IV (deleted).

(U) SECTION V, ENEMY DEFENSES AND FRIENDLY COUNTERMEASURES (SECRET), is subdivided into 7 parts: Part 1 describes the anti-aircraft missile threats which may be encountered; part 2 describes anti-ship missile threats; part 3 describes the anti-aircraft artillery systems which may pose a threat to the aircrew; part 4 discusses the general design techniques and specific equipment characteristics for various types of airborne electronic warfare equipment; part 5 describes evasive maneuvers and formations which have been investigated for effectiveness against surface-to-air missiles; part 6 presents recommendations for formations and tactics to be used against surface-to-air threats; part 7 describes air-to-air equipment designed to aid the aircrew in identification of target aircraft.

(U) APPENDIX A, OPERATING LIMITATIONS, describes the operating limitations on the aircraft and its weapon systems.

(U) APPENDIX B, INTELLIGENCE (SECRET), presents tactics that the enemy can be expected to employ during air combat.

(U) APPENDIX C, QUESTION BANK, presents questions concerning tactical employment of the aircraft and its weapons system.

(U) HOW TO OBTAIN COPIES

(U) ADDITIONAL COPIES

(U) To obtain copies of this publication submit a NAVSTRIP Form DD 1348 in accordance with instructions contained in the NAVSUP manual and NAVSUP publication 2002.

(U) AUTOMATIC DISTRIBUTION

(U) To receive future changes and revisions to this manual automatically, a unit must be established on the automatic distribution list maintained by the Naval Air Technical Services Facility (NATSF). To be established on the list or to change distribution requirements, a unit must submit NAVWEPS Form 5605/2 to NATSF, 700 Robbins Avenue, Philadelphia, Pennsylvania 19111, listing this manual and all other NAVAIR publications required. For additional instructions refer to BUWEPS-INST 5605.4 series and NAVSUP publication 2002.

(U) POCKET GUIDE

NEW

(U) The F-4B/N and F-4J Tactical Manual Pocket Guide is not distributed automatically with this manual and therefore, must be ordered as a separate publication using the previously described procedures for Tactical Manuals. The Pocket Guide is printed on cardboard stock and is designed to be fastened to the aircrew's knee pad. The Pocket Guide contains the essential data required to provide inflight flexibility.

(U) TACTICAL MANUAL BALLISTICS TABLES

(U) The Tactical Manual Ballistics Tables contain additional information which is common to all tactical aircraft such as trajectory drop, down range travel, etc. for various weapons. This publication is not distributed automatically with the Tactical Manual and therefore, must be ordered as a separate publication in the same manner as the Pocket Guide.

(U) UPDATING THE MANUAL

(U) To ensure that the manual contains the latest procedures and information a review conference is held periodically as necessary.

(U) YOUR RESPONSIBILITY

(U) The Tactical Manual is kept current through an active manual change program. If you find anything you don't like about the manual, if you have information you would like to pass on to others, or if you find an error in this manual, submit a change recommendation to the Model Manager at once.

(U) CHANGE RECOMMENDATIONS

(U) Recommended changes to this manual may be submitted by anyone in accordance with OPNAVINST 3510.12 (series). Change recommendations of an URGENT nature should be submitted directly to the originator's Type Commander by Priority message. Submit Routine change recommendations to the Tactical Manual Model Manager on OPNAV Form 3500-22 and address to:

Commanding Officer
Air Test Evaluation Squadron Four
Navy Missile Center
Point Mugu, California 93041

(U) INTERIM CHANGE SUMMARY

(U) The Interim Change Summary is provided for the purpose of maintaining a complete record of all Interim Changes issued to the manual. Each time the manual is changed or revised, the Interim Change Summary will be formally updated to indicate disposition and/or incorporation of previously issued Interim Changes. When a regular change or revision is received, the Interim Change Summary should be checked to ascertain that all outstanding Interim Changes have been formally incorporated or canceled. Those changes that were not incorporated should be noted as applicable.

(U) CHANGE SYMBOLS

NEW NEW

(U) Revised text is indicated by a black vertical line in either margin on the page, like the one printed next to this paragraph. The change symbol shows where there has been a change. The change might be material added or information restated.

(U) WARNINGS, CAUTIONS AND NOTES

(U) The following definitions apply to WARNINGS, CAUTIONS, and NOTES found throughout the manual:

WARNING

An operating procedure, practice, etc., which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION

An operating procedure, practice, etc., which if not strictly observed, could result in damage to, or destruction of, equipment.

Note

An operating procedure, condition, etc., which is essential to emphasize.

(U) WORDING

(U) The concept of word usage and intended meaning which has been adhered to in preparing this manual is as follows:

"Shall" has been used only when application of a procedure is mandatory.

"Should" has been used only when application of a procedure is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degreee of requirement for application of a procedure.

CONFIGURATION STATUS

Modifications to the aircraft and weapons system applicable to the Tactical Manual are listed on the following configuration status sheets. F-4B/N modifications are listed first followed by F-4J modifications. F-4N aircraft are listed in production column when modification is incorporated in all F-4N aircraft.

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4B/N	AAC 469			-6B	MER/TER-7 automatic homing mode.
F-4B/N	AAC 492				MER/TER-4 stores sensing switch relocated to rack hooks.
F-4B/N	AAC 483 AAC 587				Modified LAU-7/A launcher and adapter for AIM-9G SEAM.
F-4B/N	AAC 509		774		MER/TER-7 automatic homing. Allow station step with RKT DISP and ALL selected. Requires STEP switch to release.
F-4B/N	AAC 537				Adds detent hold-down pin on LAU-7/A launcher to prevent missiles from being ejected backwards during catapult launch.
F-4B/N	AAC 545				Adds fin retainer springs on LAU-7/A launcher that snaps over AIM-9D/G fins and prevents fin flutter during captive flight.
F-4B/N	Interim AAC 558				Centerline MER adapter wire bundle modification to remove the right pulse from the aircraft intervalometer.
F-4B	AFC 78	F-4N and F-4B 1504061 (block 12)			Multiple weapons system.
F-4B	AFC 162	F-4N and F-4B 151498t (block 20)			MK43 and MK57 capability.
F-4B	AFC 241	F-4N and F-4B 152278w (block 23)			Changes master arm switch position to CONV OFF-NUCL ON.
F-4B	AFC 288	F-4N	641 R1		Adds data link system and data link switch on weapons control panel.
F-4B	AFC 296	F-4N	707 R1		Provisions for installation of AN/APR-27 radar receiving set.
F-4B	AFC 296 and AFC 339	F-4N	707 R1 761		Provisions for installation of AN/APR-27 radar receiving set or the AN/ALQ-91 countermeasures set.

CONFIDENTIAL

FDB-1T-(6-1)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4B	AFC 331	F-4N	703 S1		Provisions for installation of KY-28 speech security unit.
F-4B	AFC 333	F-4N	707 R1 S1 707 R1 S2		Provisions for AN/APR-30 radar homing and warning set, AN/ALQ-51A/100 countermeasures set, and AN/ALE-29A chaff dispenser.
F-4B	AFC 334	F-4N	761 S1		Provisions for installation of AN/APR-27 radar receiving set or AN/ALQ-91 countermeasures set.
F-4B	AFC 336	F-4N	746		Provides CONLABS delivery mode. CONLABS provides a ripple release loft bomb capability.
F-4B	AFC 346 Amendment No. 1	F-4N			Removes ALL position from the missile jettison selector switch.
F-4B	AFC 352	F-4N	687 S3		Provisions for AN/APX-76A interrogator set.
F-4B	AFC 375 PT I	F-4N	830		On aircraft with AFC 333, the AN/APR-30 radar homing and warning set is replaced with the AN/APR-25 radar homing and warning set.
F-4B	AFC 375 PT II	F-4N	707 R2		Provisions for installation of AN/APR-25 radar homing and warning set, AN/ALQ-51A/100 countermeasures set, and AN/ALE-29A chaff dispenser.
F-4B	IAFC 424	F-4N			Pilot lockon modification. With IAVC 862, enables pilot to lock radar on target. Nose wheel steering button is utilized for initiating lockon. A sweep select switch is provided on bullpup panel for selecting direction of automatic range gate sweep. On F-4N and F-4B with VTAS, target acquisition enable (TAE) switch on control stick is utilized to initiate radar lockon.
F-4B	AFC 448	F-4N	896 R1		Provides a singles chaff switch on the right throttle in front cockpit. Enables pilot to dispense chaff.
F-4B	AFC 450	F-4N	912		Modified AIM-7 tuning and select circuit operation. Pseudo circuits are removed and firing circuits are modified to provide more meaningful SELECTED lights. Missiles indicate their tuned status after being armed and lockout circuits are modified to provide capability of selecting previously locked out missiles if they tune. With AVC 860, allows pilot to select AIM-7E-2 dogfight mode in flight. If AVC 860 is not incorporated, the dogfight mode must be manually selected on the missile before flight.

CONFIDENTIAL

FDB-1T-(6-2)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4B	AFC 451	F-4N	918		Relocation of guns switch.
F-4B	AFC 452	F-4N	906		Relocates redesigned AN/ALQ-91 teaser lights panel to top left side of main instrument panel. Adds glare shields on AN/APR-25 strobe display scopes and relocates RIO ECM warning lights panel. Modification improves visibility of warning lights.
F-4B	AFC 476	F-4N	912 S2		Probability of speedgate lockon after missile launch is improved by adding sweep select delay relay.
F-4B	AFC 500	F-4N	971 A1		Installs visual target acquisition set (VTAS) and provides Sidewinder expanded acquisition mode (SEAM).
F-4B	AFC 516	F-4N	850 R1 S1		Provides capability to carry AIM-7F.
F-4B	AFC 517	F-4N	970 R1		Installs dogfight computer which provides ACM launch zone indications.
F-4B	AFC 524	F-4N	1023 A2		Installs AN/ALR-45 countermeasures receiving set and AN/ALR-50 radar receiving set which replace the AN/APR-25 radar homing and warning set and AN/APR-27 radar receiving set respectively.
F-4B/N	AFC 290			146 R2	Fold down optical sight with 60-mil reticle.
F-4B/N	AVC 464				Movable optical sight combining glass (Modified A-1 sight).
F-4B/N	AVC 478			160	Provides range lights in front cockpit which indicate range scale selected by RIO.
F-4B	AVC 532	F-4N	746	158	Radar bombing capability is provided by a fixed range strobe on radar scope display.
F-4B	AVC 577	F-4N		168R	Provides data link radar scope displays.
F-4B	AVC 661 AVC 662	F-4N		178	Adds target aspect switch which provides capability of improving AIM-7 launches in boresight mode.
F-4B	AVC 664	F-4N		188	Provides capability of displaying AN/APX-76 and AN/ALQ-91 interrogations on radar scopes.
F-4B/N	AVC 679				Provides automatic range and angle track in boresight after lockon.

CONFIDENTIAL

FDB-1T-(6-3)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4B	AVC 860	F-4N	912		Provides automatic AIM-7E-2 dogfight mode selection capability. With AFC 450, pilot may also manually select dogfight mode.
F-4B	IAVC 862	F-4N			Pilot lockon modification. Refer to IAFC 424.
F-4J	AAC 469			-6B	MER/TER-7 auto homing mode.
F-4J	AAC 492				MER/TER-4 stores sensing switch relocated to rack hooks.
F-4J	AAC 483 AAC 587				Modified LAU-7/A launcher and adapter for AIM-9G SEAM.
F-4J	AAC 509	155570ah (block 34)	774 930		MER/TER-7 Automatic Homing. Allows station transfer with RKT DISP and ALL selected. Requires STEP switch to release.
F-4J	AAC 537				Adds detent hold-down pin on LAU-7/A launchers to prevent missiles from being ejected backward during catapult launch.
F-4J	AAC 545				Adds fin retainer spring on LAU-7/A launchers that snaps over AIM-9D/G fins and prevents fin flutter during captive flight.
F-4J	Interim AAC 558				Centerline MER adapter wire bundle modification to remove the right pulse from the aircraft intervalometer.
F-4J	AFC 331	155529ag (block 33)	703 S1		Provisions for installation of KY-28 speech security unit.
F-4J	AFC 346 Amendment No. 1	153900af (block 32)			Removes the ALL position from missile jettison selector switch.
F-4J	AFC 388	155529ag (block 33)	840	14	Provides radar bombing capability and CONLAB delivery mode.
F-4J	AFC 388	153840ae (block 31)	840	15	Permits rf antenna radiation while aircraft is on ground provided pulse mode is selected and cw transmitter is OFF. Provides capability of tracking lead aircraft during takeoff.

CONFIDENTIAL

FDB-1T-(6-4)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4J	AFC 388 AFC 417	155529ag (block 33)	758 S2 758 S3 758 S4 758 S5	46	Antenna is modified for installation of AN/APX-76A antenna. With 1413 configuration radar sets or with AVC 750, radar scopes are modified to provide capability of displaying AN/APX-76A and AN/ALQ-91A interrogation displays. BIT frames are provided for checking AN/APX-76A and AN/ALQ-91A displays.
F-4J	AFC 388 AFC 453	155793ai (block 35)	687 S9		Provides fault indicating lights on No. 1 circuit breaker panel for AN/APX-76A that enable RIO to isolate faults in AN/APX-76A.
F-4J	AFC 388	155529ag (block 33)	641 R1 840 S2		Provides AN/ALE-29A chaff dispenser, data link system, provisions for AN/APR-25 radar homing and warning set, provisions for AN/ALQ-51A/100 countermeasures set, provisions for AN/ALQ-91A countermeasures set, provisions for AN/APN-154 radar beacon set, and provisions for AN/APX-76A interrogator set.
F-4J	AFC 388	155529ag (block 33)			Adds data link switch to weapons control panel.
F-4J	AFC 448	155844aj (block 36)	896 R1		Provides a singles chaff switch on the right throttle in the forward cockpit. Provides pilot with capability of dispensing chaff.
F-4J	AFC 450	155844aj (block 36)	912	99	Modified AIM-7 tuning and select circuit operation. Also adds dogfight mode selection capability in the forward cockpit. Pseudo circuits are removed and firing circuits are modified to provide more meaningful SELECTED light illuminations. Missiles also indicate their tuned status after being armed. Missile lockout circuits are modified to provide capability of selecting previously locked missiles if they tune. With 1527 configuration radar sets, the added dogfight selection capability in the front cockpit allows pilot to select dogfight mode in flight. Automatic dogfight mode selection is also provided when it is not selected by pilot. Without 1527 configuration radar sets, the dogfight mode must be manually selected on the missile before flight.
F-4J	AFC 451	155890am (block 39)	918		Relocation of gun switch.

CONFIDENTIAL

FDB-1T-(6-5)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4J	AFC 452	155890am (block 39)	906		Relocates redesigned AN/ALQ-91 teaser lights panel to top left side of main instrument panel. Adds glare shields for AN/APR-25 strobe display scopes and relocates RIO's ECM warning lights panel. Modification improves visibility of warning lights.
F-4J	AFC 463	155875al (block 38) thru 158354as (block 45)	927		Provides cooling air diverter valve to improve cooling during ground operation in pulse mode.
F-4J	AFC 476	157261ao (block 41)	912 S2		Probability of speedgate lockon after missile launch is improved by adding sweep select delay relay.
F-4J	AFC 506	158355at (block 46)	958	128	Cockpit optimization for ACM. Modifications in front cockpit include: addition of SHOOT and SEAM lights; installation of a new air-to-air control panel which has dogfight mode select provisions, an integrated gun and missile arm switch, a new AIM-9 coolant switch, and a selective jettison switch; installation of a weapon select switch and a target acquisition enable switch on the control stick; redesigned and relocated missile status panels; installation of a weapon status panel; and a weapon lights reset provision. Modifications in the rear cockpit include: improvements in forward visibility; addition of radiation hazard lights, fuel gauge, and AOA indicator; relocated radar set control panel and antenna hand control; and installation of a weapon status panel with READY and SHOOT lights. Modifies AN/ALE-29A chaff dispenser set to provide capability for selecting countermeasures material to be ejected (chaff or flares). Modifies gun firing switchology.
F-4J	AFC 506	158355at (block 46)	971 A1	83	Installs visual target acquisition set (VTAS) and provides Sidewinder expanded acquisition mode (SEAM).
F-4J	AFC 514	158355at (block 46)	996	123	Provides line of sight rate to AIM-7 to enhance missile lockon in ACM environment.
F-4J	AFC 515	158355at (block 46)	993	69R	Adds radiation hazard lights.

CONFIDENTIAL

FDB-1T-(6-6)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4J	AFC 516	158355at (block 46)	850 R1 S1		Provides capability to carry AIM-7F.
F-4J	AFC 517	158355at (block 46)	970 R1		Installs dogfight computer which provides ACM launch zone indications.
F-4J	AFC 524		1023 A2		Installs AN/ALR-45 countermeasures receiving set and AN/ALR-50 radar receiving set which replace the AN/APR-25 radar homing and warning set and AN/APR-27 radar receiving set respectively.
F-4J	AVC 498	153071z (block 26)			Fold down optical sight with 60-mil reticle.
F-4J	AVC 750	1413 configuration radar sets		46	Radar scopes are modified to provide capability of displaying AN/APX-76A and AN/ALQ-91A interrogation displays.
F-4J	AVC 833A	1472 configuration radar sets		64	Provides increased antenna slew rate and the delayed range rate circle display is eliminated. V_c is supplied to the simulated doppler circuits concurrently with the range rate circle display. This provides the capability of earlier speedgate locks. Before the modification, the simulated doppler circuits did not receive the V_c signal until after a 1.5 second delay from lockon.
F-4J	AVC 834	1413 configuration radar sets		50	Provides feedhorn nutation in the VI and 10-mile pulse modes while in search.
F-4J	AVC 852	1527 configuration radar sets		106	Provides automatic range and angle track in boresight after lockon.
F-4J	IAVC 873				Provides capability of removing B+ power when not needed during BIT checks and when preparing for takeoff.

CONFIDENTIAL

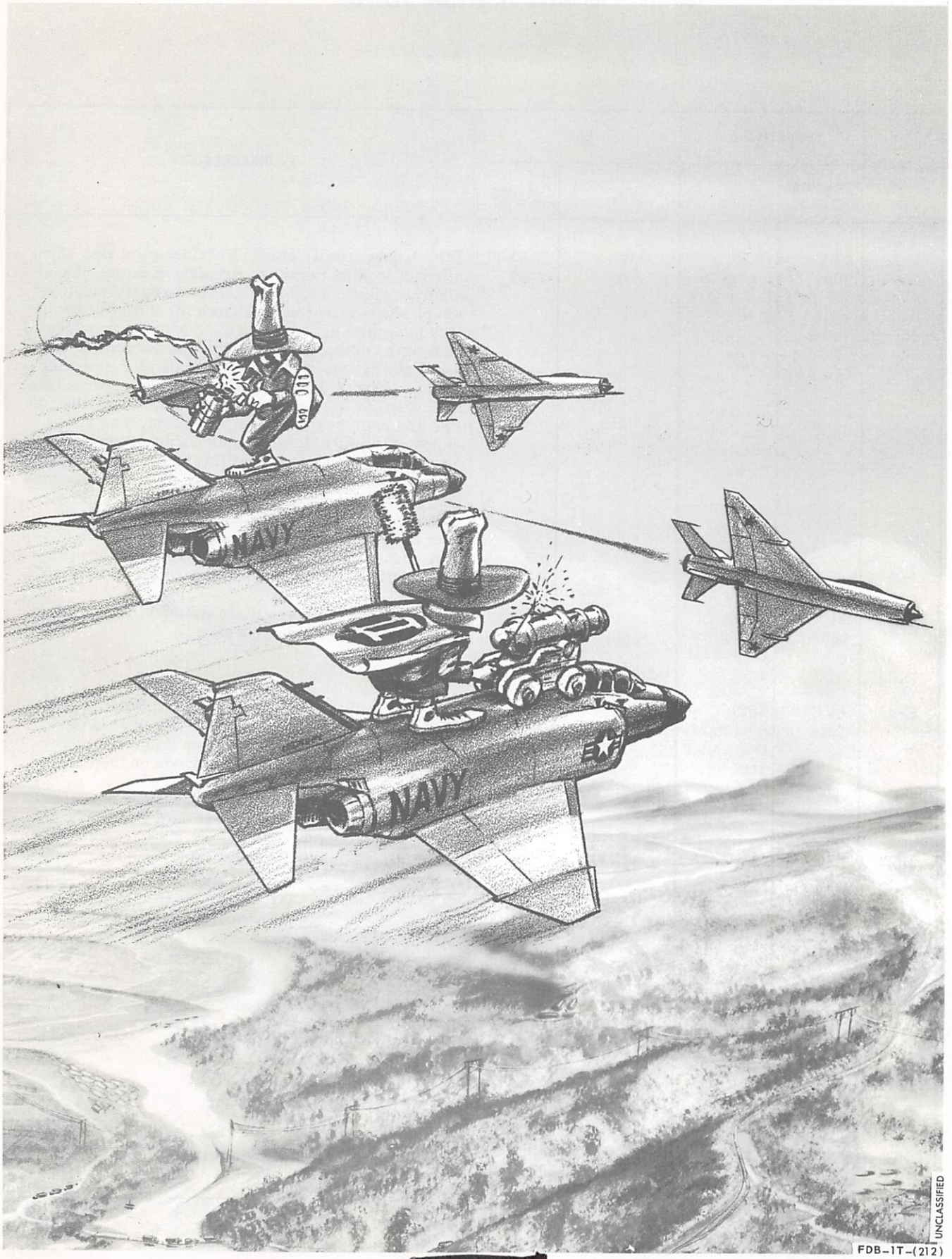
FDB-1T-(6-7)

CONFIGURATION STATUS

AIRCRAFT	EFFECTIVITY		ECP		DIFFERENCE
	TECHNICAL DIRECTIVE	PRODUCTION	MDC	VENDOR	
F-4J	AVC 1054	1527 configuration radar sets	911	83 99	Pilot lockon modification. Provides pilot with capability of locking radar on boresighted target. On aircraft without 1527 configuration radar sets, nose wheel steering button is utilized for initiating the lockon sequence. An STC gain control is provided to reduce the probability of locking on the altitude line and a sweep select switch is provided for selecting the direction of the automatic range gate sweep. On aircraft with 1527 configuration radar sets, altitude line and main beam clutter reject features are incorporated in PLM; selectable acceleration limits are provided; and radar settling times are reduced. With VTAS, pilot may lock radar on non-boresighted targets. These aircraft have a fixed STC in PLM with no sweep select switch. Lockon is initiated with target acquisition enable (TAE) switch on control stick. 1527 configuration radar sets also provide dogfight selection capability (refer to AFC 450).
F-4J	AVC 1092	1527 configuration radar sets		123	Provides line of sight rate to AIM-7 to enhance missile lockon in ACM environment.
F-4J	AVC 1095	1527 configuration radar sets		69R	Provides radiation hazard lights to minimize probability of-radiation hazards while aircraft is on deck. Also provides B+ OFF function to allow reduced heating during waiting periods on the deck.
F-4J		157242an (block 40)	758 S6		Installs AN/APR-25 control panels whereas before only provisions for panels were provided.
F-4J		158346as (block 45)	989		AWW-4 fuze function control set.

CONFIDENTIAL

FDB-1T-(6-8)



FDB-1T-(212)

SECTION I

AIR-TO-AIR WARFARE

TABLE OF CONTENTS

PART 1 AIR COMBAT MANEUVERING . . 1-1
Introduction 1-2
Aircraft Capabilities 1-3
Tactical Doctrine 1-7
Tactical Principles 1-7
NEW Cockpit Checks 1-8
Fighter Versus Fighter Maneuvering . . 1-11
Loose Deuce Concept 1-36
NEW Loose Deuce Tactics 1-36
Engaging Multiple Bogeys 1-76
Disengagement Techniques. 1-76
Division Formations 1-77
Combat Performance Charts 1-80

PART 2 RADAR TECHNIQUES 1-136
AN/APG-59 Radar Detection and Track . 1-136
AN/APQ-72 Radar Detection and Track . 1-147
F-4B/N and F-4J AIM-7 Firing Delay. . 1-154
NEW Visual Target Acquisition Set 1-155
NEW AN/APX-76A Interrogator Equipment Set. 1-156

PART 3 WEAPON SYSTEM 1-158
System Malfunctions 1-158
AIM-7 Missile 1-161
AIM-9 Missile 1-170
Air-To-Air Employment of MK 4 Gun Pod 1-188

PART 4 ESCORT 1-203
Strike Force Protection Tactics 1-203

PART 5 COMBAT AIR PATROL. 1-205
Briefing Requirements 1-205
Procedures 1-205
CAP Patterns 1-206
Specialized CAP 1-206

PART 6 INTERCEPT 1-207
Classic One-On-One Intercept Maneuvers 1-207
Attack Phase 1-210
Low Altitude Targets 1-214
Medium Altitude Subsonic Targets . . . 1-218
High Altitude Supersonic Targets 1-219
Very High Altitude Subsonic Targets . . 1-220
In-Trail Tactics (All Weather) 1-220
Reattack 1-221
Data Link 1-222

PART 7 MISSILE FIRING EXERCISE . . . 1-229
Air Intercept Missiles. 1-229
Air-To-Air Missile Targets 1-238

PART 8 ECM/ECCM. 1-242

PART 1 AIR COMBAT MANEUVERING

"Fighter pilots have to rove in the area alloted to them in any way they like, and when they spot an enemy they attack and shoot them down --- anything else is rubbish."

RICHTHOFEN

"Only the spirit of attack borne in a brave heart will bring a success to any fighter aircraft, no matter how highly developed it may be."

NEW

ADOLPH GALLAND

INTRODUCTION

(U) GENERAL

(U) In every major conflict since WWI, airplanes have been utilized to destroy other airplanes. At the close of each conflict, there were assurances that air combat was obsolete and doomed to reminiscence. The names, weapons, areas, and airplanes have all changed, but the basic tactics have remained the same. Technological advances and new weapons have expanded the areas and placed greater demands on the intellect of the aircrew. Thus, actual techniques and specific functions differ, but the basic tactics are unchanged. The aircrew must still analyze their own skills, airplane, and weapons, and weigh them against their adversary in order to employ each to its maximum. The tactics discussed in this section assume that the enemy aircraft is being flown by an aggressive, well trained pilot. One-on-one tactical maneuvers can be aggressively commenced if the enemy pilot proves himself incompetent.

(U) Air Combat Maneuvering (ACM) is that phase of air warfare in which the fighter operates in close proximity to the enemy aircraft, and brings its weapons to bear primarily through the employment of large-scale, three-dimensional maneuvers.

(C) The ACM environment is characterized by high levels of acceleration and deceleration, widely varying speeds and altitudes, and high angular rates of the aircraft about its pitch, roll, and yaw axes. In general, each combatant is attempting to position his aircraft in a favorable firing position relative to his opponent, a process which becomes increasingly difficult in direct proportion to limitations of the weapon envelope (range, aspect angle, off-boresight capability, etc.) and to improvements in target aircraft maneuvering performance. The aircraft will normally remain in relatively close proximity to each other during the engagement, and the crews will attempt to maintain continuous visual contact at all times. No phase of aerial combat places greater demands on the crew-aircraft combination. The successful outcome of any ACM engagement will depend almost entirely on the manner in which the pilot employs the performance capabilities and advantages of his aircraft relative to those of the enemy. It is this relationship between aircraft performance and pilot utilization of it that serves as the basis of ACM tactics.

(U) It is the purpose of this part to present the reader with a thorough knowledge of those characteristics of the F-4 which relate to optimum aircraft employment in the ACM environment; and to indicate how maximum effectiveness may be achieved through a combination of excellent aircraft performance, classical maneuvering, crew teamwork, and good tactical principles and doctrine.

(C) Air Combat Maneuvering, as a phase of air-to-air warfare, results any time combatants close to visual range. This situation can occur, for example, as a logical consequence of the employment of a visual identification (VID) doctrine which requires an initial close approach to the bogey aircraft.

(C) Finally, ACM is the almost inevitable result of any surprise attack by enemy fighters. In the event that the enemy is not initially detected until at close range, there will seldom be any option but to engage in ACM.

(C) Inherent aircraft air combat maneuvering effectiveness is determined primarily by aircraft turning performance, energy maneuverability, aircraft weapons system, and the enemy threat. The F-4 series fighter instantaneous turning performance below 425 KCAS (G available) is inferior to MIG 17-21 aircraft. However, its energy level and sustained G capability below 15,000 feet are superior. The F-4 weapon system provides a larger launch zone than that available to enemy aircraft, but it is not in reality an all aspect system during air combat maneuvering. The realistic launch envelope is astern to abeam on the inside of the bogey's turn. (The launch zone is discussed in part 3 of this section.) Thus, the F-4 fighter crew is faced with almost the same task as other fighter aircraft throughout the history of air-to-air warefare; they must achieve a kill by out maneuvering the enemy and then attack from the rear hemisphere. The aircraft with smaller turn radius (more G available at a given speed/altitude) will normally win a classic close-in turning fight. The F-4 does not possess this capability against most MIG series aircraft. This disadvantage plus the fact that the quickest and safest way to destroy an enemy aircraft is to team up against him dictates that F-4 tactical doctrine be based on two-versus-one maneuvering.

(C) Fighter aircraft effectiveness is measured directly by the ability to destroy other fighter aircraft in the air. Victory in air combat is not, however, a simple matter; it is heavily dependent on a great many factors which may be arranged into the following major categories.

a. Performance -
   - Unloaded acceleration and climb rate
   - Sustained turn capability
   - Maximum instantaneous turn capability
   - Available combat time

b. Human Factors -
   - Cockpit visibility
   - Switchology
   - Harness and restraints
   - Cockpit environment (noise, temperature, etc.)
   - Displays
   - Personal equipment
   - Crew teamwork

(C)

c. Flying Qualities/Stability and Control -
   - Roll rates
   - Stick forces
   - Rudder control
   - Roll-sideslip characteristics
   - Static - dynamic stability
   - Damping (roll, pitch, yaw)
   - Trim changes and trim rates

d. Operational -
   - Air-to-air ordnance (amount, type, capabilities)
   - Mission radius
   - Mission support operations (e.g., tankers, EW, RESCAP, etc.)
   - Enemy detection/warning
   - Mission type (escort, CAP, sweep, etc.)
   - Force size
   - Tactical doctrine and principles
   - Rules of engagement

e. Uncontrollable or unpredictable -
   - Weather
   - Enemy capabilities
   - Enemy tactics
   - Pilot skill
   - Element of surprise
   - Luck

(U) In analyzing a fighter it should always be remembered that there is no such thing as the absolute fighter. A fighter is only "good" or "bad" when compared to another fighter; i.e., the F-8 was good compared to the F-1, and F-4 is a good fighter when compared to the MIG-21, etc.

(U) Comparing fighters is something a pilot does on every tactics hop. There have been many attempts to compare airplanes prior to fighting them. These analytical methods were given great impetus by Boyd's theory of Energy Maneuverability. The attempts to compare fighter performance are being continually updated and verified. Briefly stated, maneuverability is the ability to change the magnitude and/or direction of the velocity vector of an airplane. This definition is of little value by itself. Refer to Aircraft Maneuverability, this section.

AIRCRAFT CAPABILITIES

(U) AIRCRAFT PERFORMANCE

(U) The aircraft should not be employed as a single aircraft in a fighter versus fighter environment. However, the basic aircraft performance capabilities must be understood and are applicable to formation maneuvering. Figure 1-1 provides the indicated angle of attack which corresponds to various flight regimes. Optimum acceleration is obtained in an unloaded condition. Lowest drag occurs at 3-5 units angle of attack. At medium to high altitude, buffet onset occurs early and is several G away from stall. Therefore, it cannot be used to define optimum turn. A 16-unit angle of attack turn will produce a relatively good rate of turn without excessive energy bleedoff. Optimum (tightest) turning radius is obtained between 18 and 21 units angle of attack, depending on Mach and altitude. This means pulling considerably deeper into buffet than is experienced with most other aircraft. It should be practiced to the point where the pilot does not need to refer to the angle of attack indicator. Above 21 units angle of attack, an extremely high rate of energy loss due to drag is encountered. At low altitude the aircraft turning capability is limited primarily by placard G limit and angle of attack. At medium altitude the ability to sustain turn becomes less and less due to decreasing thrust (see figure 1-42). Above 36,000 feet supersonic, maximum turn is normally limited by the stabilator deflection limit. However, it is possible to stall the aircraft with no warning below Mach 1.2 above 40,000 feet. Since the placard G limit for the F-4 changes radically with Mach, the following rule of thumb can be employed: Below 37,000 pounds gross weight subsonic, do not exceed 7 G. Supersonic, do not exceed 6.5 G. More detailed information on F-4 placard limits is contained in appendix A of this manual. Figures 1-38 and 1-39 present F-4B/N and F-4J maneuverability diagrams. These charts show aircraft specific power (P_S) at a given Mach and G for various altitudes and power settings. Specific power can be defined as unaccelerated rate of climb capability and thus, the maneuvering capability of the aircraft during any given condition. The P_S = 0 ft/sec curve represents maximum sustained G for Mach, altitude, power setting, and gross weight combination.

Note

Sustained G decreases proportionately as aircraft gross weight increases; e.g., a 10 percent increase in gross weight results in a 10 percent decrease in sustained G.

(U) F-4B/N and F-4J Performance Differences

(U) Although the energy charts for the F-4B/N and F-4J indicate significant differences in sustained energy levels, little difference can be noted in the cockpits during the dynamics of an actual air-to-air engagement. This observed similarity in performance is due to the fact that at comparable fuel loads, the F-4J is considerably heavier than the F-4B/N.

(U) HIGH SPEED CHARACTERISTICS

(U) Performance of the F-4 in the high Q (high CAS) environment is definitely superior to present MIG series aircraft, and most other fighters. The aircraft responds well to roll and pitch commands and displays none of the adverse characteristics usually associated with high Q flight. Due to these factors plus the rapid acceleration capability of the aircraft

AIR COMBAT MANEUVERING ANGLE OF ATTACK GUIDE

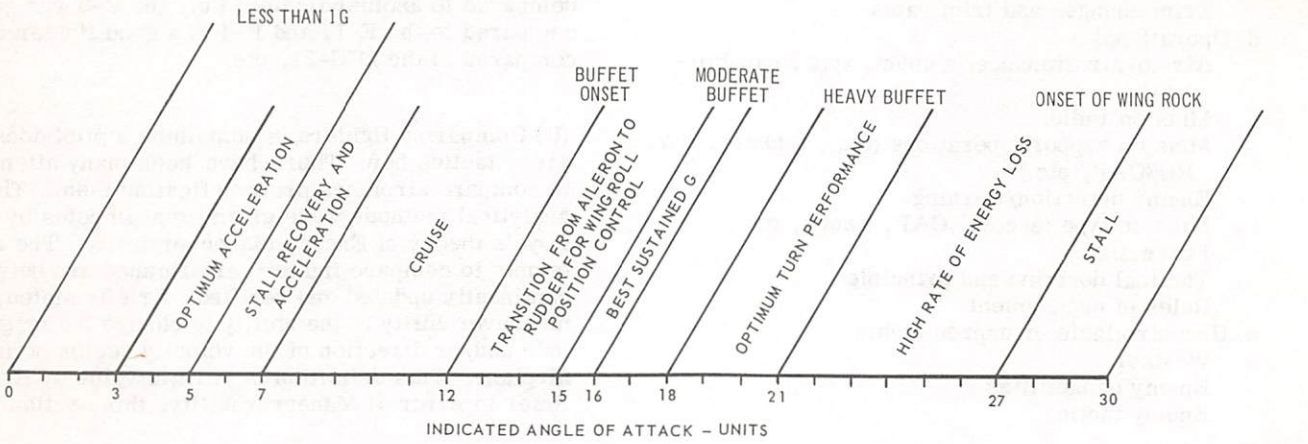


Figure 1-1 (U)

in unloaded flight, care must be taken not to exceed the 750 knots CAS limit. Consideration must also be given to the fact that G available above 500 KCAS far exceeds that required to cause catastrophic destruction of the aircraft.

(U) RATE OF ROLL AND ADVERSE YAW

(U) When maximum rate of roll is required below 300-350 KCAS, rudder in the direction of roll must be used to increase roll rate and counter the adverse yaw tendency of the aircraft. This becomes more necessary at slower airspeeds. Adverse yaw is defined as the tendency of the aircraft to yaw or roll away from the intended turn due to aileron deflection. In the F-4, this condition is present under subsonic conditions at high angles of attack. As the angle of attack increases, both adverse yaw potential and dihedral effect (force causing the aircraft to roll in the direction of rudder induced yaw) also increase. At low angles of attack (below 12 units), the ailerons produce good roll rates with little or no yaw, and the rudder produces large amounts of yaw with a low rate of roll.

At optimum turning angle of attack (18-21 units), the rudder produces a good roll rate with little yaw while the ailerons produce only adverse yaw causing the aircraft to roll opposite the direction intended. Because of this, a definite control technique with respect to roll is required. Below 12 units angle of attack, use aileron only to roll the aircraft. Between 12 and 16 units, use coordinated rudder and aileron in the intended direction of roll, decreasing use of aileron as angle of attack increases. Above 16 units angle of attack, use rudder only to generate roll. When rate of roll is the only consideration, the most rapid roll rate may be obtained by reducing angle of attack and using full aileron and rudder in the direction of roll. However, this method does not offer the most rapid flight path reversal.

WARNING

Do not arbitrarily use full rudder and opposite aileron to achieve a maximum performance turn. If this is attempted, a large amount of favorable yaw will be generated and a snap roll (departure) with possible subsequent spin will probably occur.

Note

Do not use ailerons to counter wing rock.

(U) Further discussion of departure/spin recovery techniques are contained in the NATOPS Flight Manual.

(U) USE OF STABILITY AUGMENTATION

(U) With aircraft having only the single-switch stability augmentation system, stab aug should be left engaged during Air Combat Maneuvering (ACM).

However, with aircraft having the three-switch selectable stability augmentation system, the following recommendations are made:

a. Pitch aug - ON
   Pitch augmentation is definitely required to provide adequate pitch stability during high Q flight.
b. Roll aug - OFF
   When the roll sensors detect a rate of roll not commanded by the stick, the roll augmentation attempts to stop the roll with aileron deflection. At high angles of attack this deflection can cause adverse yaw in opposition to rudder induced roll. Turning roll aug off does not change normal lateral stability during maneuvering flight, and removes this problem.
c. Yaw aug - AS DESIRED
   Turning off yaw augmentation increases cockpit rudder authority by removing the ability of the stab aug system to counter unwanted yaw with rudder. This increases the high angle of attack rolling capability of the aircraft. However, this is not without penalty. With yaw aug off, aircraft directional stability is poor. Some pilots find it unacceptable. Others can live with it to get the improved rudder authority. Regardless, it may be necessary to reengage yaw aug in order to properly track with the AIM-9D missile.

(U) USE OF FLAPS

(U) At 230 KCAS and below, the use of half flaps will increase G by approximately 1/2 G. Use of full flaps will further increase G available, but will also drastically increase drag and decrease stabilator effectiveness. When utilizing flaps remember that any time there is a change in configuration, the BLC malfunction light must be monitored.

Note

Wing mounted missiles cannot be fired with the flaps switch in any position but UP.

(U) ENGAGEMENT

(C) The best fighting altitudes for the F-4 are below 15,000 feet. The shaded area of figure 1-2 depicts the optimum fighting zone. Above 16 units angle of attack, turns should be made using the rudder and stabilator as primary control surfaces. Inspection of the F-4 and MIG series aircraft Energy-Maneuverability (EM) charts and the F-4 aircraft-weapon system capabilities indicates the following advantages for going low and maneuvering below 15,000 feet:

a. Specific Energy (E_S) build up is maximized.
b. Specific Excess Power (P_S) is maximum and better than most MIG series aircraft.
c. Maximum maneuverability (instantaneous and sustained).
d. Fuel economy and efficiency (minimum use of afterburner)
NEW e. Optimum disengagement capability.
f. More opportunity to fire the AIM-7/AIM-9 looking up.
g. Reduced minimum missile range.
h. Reduced ATOLL (AA-2) missile range.
i. Maximum CAS limit advantages.
j. Reduced SAM envelope.

(C) Inspection of the instantaneous turn radius chart and the energy maneuverability charts (figures 1-38, 1-39, and 1-41) shows that below 20,000 feet, turn radius is roughly constant from 300 KCAS to structural limits, while the level of highest specific energy below 20,000 feet is between 450 - 500 KCAS or structural limit. Therefore, the optimum operating zone during engagement is above 450 KCAS near the optimum energy level. The following speeds should be remembered when in an ACM environment:

a. Placard limit - 750 KCAS
b. Optimum for vertical reversal - 550 KCAS
c. Optimum for engagement and maneuvering - 450 - 500 KCAS
d. Maximum G available commences - 450 KCAS
e. Minimum cruise - 450 KCAS
f. Minimum for high G barrel roll over the top - 350 KCAS
g. Rudder feel change over - 220 KCAS

(U) USE OF AFTERBURNER

(U) Fuel consumption, when in afterburner, is extremely high. Afterburner is most efficient when in low G, nose down situations or when at high CAS. Although it is least efficient at high angles of attack and low CAS, it may be needed under these circumstances to prevent excessive speed bleedoff and to retain a maximum energy package. Afterburners should not normally be used in high speed, high G, nose low reversal situations, since this will increase turn radius on the bottom due to the extra energy derived from afterburner. Above about 10,000 feet, a highly visible white puff of unburned fuel is emitted each time afterburner is selected or terminated. Fuel consumption at 15,000 feet is about 1500 pounds/minute with full afterburners and 600 pounds/minute with minimum afterburners. During the terminal phase of an intercept and prior to engagement, use afterburners to reduce your heavy smoke trail. Minimum afterburner will reduce this smoke significantly. Keep track of your combat fuel package. When minimum radius turns are required below 420 KCAS, use of the afterburner will increase instantaneous G available by about one-half G.

(U) FUEL MANAGEMENT

(U) Establish a combat and a bingo fuel package for areas of anticipated engagements. The combat package is that fuel remaining which is necessary to complete an intercept, a short fighter to fighter engagement, a disengagement maneuver, if necessary, followed by a low altitude, high speed egress from the threat area, and from there, a maximum range profile to a tanker or divert field. This fuel must be considered in mission planning and represents a reserve which is always available. Even though air-to-air combat may not have occurred during the patrol, NEW NEW

OPTIMUM FIGHTING ZONE

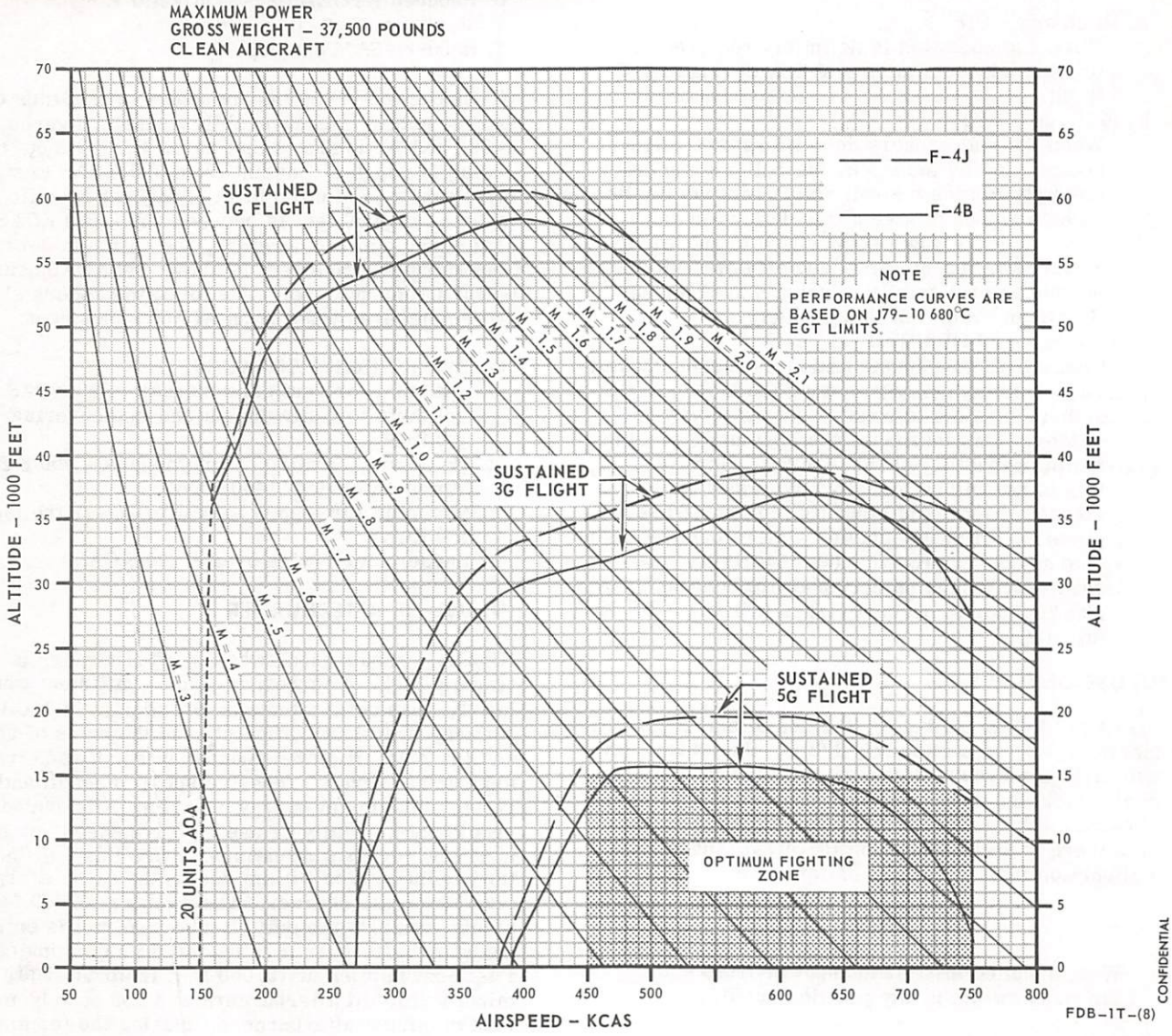


Figure 1-2 (C)

the aircrew should plan to depart the area when fuel available equals the combat package plus fuel required to retire and land. The combat package may be influenced by the availability of tankers and emergency divert fields. A bingo package is that fuel remaining which is necessary to perform just the bugout, egress, and route to tanker or divert field. As fuel remaining decreases below the combat package your combat potential rapidly decreases. If weapons cannot be brought to bear with the fuel available for combat maneuvering, the fighters must disengage in sufficient time to remain within the fuel allowance. As fuel remaining drops below the bingo package, you are in danger of fuel starvation. Before reaching the combat area, ensure that external tank fuel transfer is complete and that internal wing fuel transfer is working properly.

(U) CAPABILITIES

(C) The weapon system has a limited all aspect capability and the aircraft has excellent acceleration and climb capability. These favorable factors should be used to commence a series of slashing attacks that provide sufficient stand off capability to negate any real gun or missile threat from MIG. It is mandatory that aircrews know their aircraft and be capable of using that aircraft to the maximum capability. Aircraft advantages and disadvantages in an Air Combat Maneuvering (ACM) environment follow:

a. ADVANTAGES

(1) Two crewmembers.

(C)

(2) Good radar (except low level with pulse radar, PLM/VTAS not incorporated, refer to PLM/VTAS discussion in part 2).
(3) Good weapons system(s).
(4) Dynamically stable (not prone to spin).
(5) Good acceleration.
(6) Excellent rate of climb.
(7) Low altitude Q limit much higher than most fighters.
(8) Good sustained maneuverability above 450 KCAS at low altitude.

b. DISADVANTAGES

(1) Moderate G available above 20,000 feet and subsonic.
(2) Heavy smoke trails and burner puffs.
(3) Lack of a reliable gun system.
(4) Large size.

TACTICAL DOCTRINE

(U) Three basic building blocks of knowledge make up the manner of employment of the F-4 as an air superiority fighter. These three separate areas combine to form what is known as Tactical Doctrine, and are as follows:

a. Tactical Principles - Guidelines or rules that limit and direct the manner in which the tactical maneuvers of a specific fighter (and its configuration) are to be performed.

b. Fighter Versus Fighter Maneuvering - The objectives and relationships of the two opponent aircraft during one-on-one combat maneuvering which have not changed since the days of the FOKKER D-VII and the long silk scarf.

c. Element Tactics - The manner in which the employment of the basic element (section of two aircraft) is to be carried out to provide maximum offensive and defensive capability at any instant. An overview of the accepted F-4 section tactics is presented under Loose Deuce Concept, this section.

TACTICAL PRINCIPLES

(U) GENERAL

(U) As fundamental truths about fighter aircraft maneuvers and fighter aircrew actions are proven in combat, they become tactical principles.

(U) AGRESSIVENESS

(U) Aggressiveness (the will to win) is essential to meet and conquer the extreme stresses of air-to-air fighter combat. Unfortunately, there is a fine line between bull headed manhandling of the fighter (maximum G are not enough) and skillful use of the airplane to its limits. Fighter pilots don't look into the cockpit during a hassle; they do fly at near zero G or maximum G available.

(U) If high Q bothers you, then you don't know the F-4. It handles beautifully at high speed if pitch aug is engaged.

(U) If you're afraid of slow speed you haven't flown there enough. While good F-4 tactics preclude slow speeds at close quarters with a bogey, most engagements will find the F-4 at slow speed during some point in the engagement (hopefully far above the fight on your back positioning for a kill). In any case, the F-4 doesn't like to spin and it gives a very clear warning of stall (wing rock and then departure). If you won't hold the F-4 90° nose-up at speeds below 200 KCAS (i.e., rudder reversal), or if you're afraid to rudder roll the airplane while nose high below 150 KCAS, then you haven't flown it there enough. The F-4 has three great features for the aggressive pilot; tremendous energy, a good rudder for slow speed control, and a very honest buffet stall warning indication that precludes spinning. Fight the machine to the limit with confidence.

(U) LOOKOUT DOCTRINE

(C) Most air-to-air kills in WWI, WWII, Korea, and Vietnam were achieved through complete surprise. An even larger percentage of total kills results by adding the kills achieved shortly after a successful stern attack. In Vietnam, the enemy threat has obtained virtually no kills unless they were already in the rear hemisphere of friendlies when detected.

(C) Longevity and success in air-to-air combat requires that you see the enemy first. Every air war has produced its share of easy kills - those in which the impact of projectiles was the victim's first clue that his lookout doctrine was fatally unsatisfactory. DON'T BE A VICTIM. Avoid being taken completely by surprise. It all depends upon how much effort you're willing to devote to lookout doctrine. Don't fly around in parade formation, and don't line up on a tanker like clay pigeons anywhere near the combat zone.

(U) Scanning

(C) The technique of effective scanning requires constant practice which will improve visual acuity and

(C)
ability to see targets that otherwise might pass undetected. The effective visual scan rate is 20° per second.

(C) The threshold of visual detection is dependent on numerous factors such as aspect, atmospheric conditions (haze, smoke, moisture), background, etc. To ensure a detection at maximum distance, an effective visual search pattern must be used. The eyes should be focused approximately 5 miles away. With this focal point, the depth of field approximates a range of 1 mile to infinity. Either a horizontal search pattern which minimizes light intensity variations or a vertical search pattern may be used. No more than a 30° segment of the total area should be scanned at one time. Visual search now becomes a definite pattern instead of random looking. Use of good search techniques must be constantly practiced by all aircrews to attain and maintain optimum effectiveness in combat. In the forward quarter use radar to check the accuracy of your estimate of a bogey's range and azimuth. Take advantage of the elements. Attack from out of the sun. Consider the sun when positioning your wingman. If attacked, force the enemy to look into the sun, then change flight path when he's blinded. Know where the contrails are and avoid them. Cloud backgrounds can increase visual sighting ranges. Even a small aircraft contrasts sharply against white clouds at long ranges. Clouds can also be used as an escape when hard-pressed. In haze, visibility is increased looking down-sun and reduced looking up-sun. Be extremely vigilant when operating in or near haze layers or near clouds since the enemy can approach much nearer before being visually detected.

(U) MUTUAL SUPPORT

(C) Each member of a flight must be able to provide his teammate offensive and defensive support. Mutual offensive support is achieved when either teammate can effectively contribute the capabilities of his weapon system toward the destruction of an enemy. Mutual defensive support is realized when either teammate can force an enemy to abort his attack on the flight. When an inexperienced tactical team sights their first enemy aircraft there may be a tendency to let mutual support lapse in an effort to "get mine while the gettins good". This tendency must be countered by rigid air discipline and the knowledge that you, as a single aircraft, are in exactly the position an enemy pilot would like to find you.

(C) CLOSE COMBAT TECHNIQUES

a. Maintain 450 KCAS while patrolling; this airspeed will allow maximum G and best turn performance. Speed and lookout doctrine are the two primary factors that prevent 6 o'clock attacks.

b. Maintain a high energy level while engaged. Trade airspeed for altitude and position. Do not maneuver into a slow-speed scissors against MIG series aircraft.

c. Force the fight into the F-4 optimum fighting zone; i.e., below 15, 000 feet and above 450 KCAS (figure 1-2).

d. Maneuver in the vertical plane. At high energy levels, conditions permitting, unload, zoom to the top of the fight, and position for an attack. The low G conditions at the top of a fight plus the view while on your back, provide optimum conditions for directing and executing an attack. However, in this position, you are vulnerable to other threats (i.e., high flying fighters, SAM, etc.).

e. Maneuver for the missile launch zone (refer to ACM Launch Zone discussion in part 3). The missile launch zone is much larger than the turn radius of the aircraft and is relatively easy to reach. Maneuver the aircraft vertically into the ACM launch zone. Avoid maneuvers in the horizontal plane, particularly flat scissors type maneuvers.

f. Use lag pursuit maneuvering close-in (refer to Lag Pursuit discussion in Fighter versus Fighter portion of this section). Avoid lead pursuit against superior turning aircraft. Be patient, maneuver into the blind zone, keep a high energy level, and play the target. Anticipate his reversal and get the kill. If committed close-in, roll to the outside and fly a wider turn. This will preserve your energy, keep you in the enemy's blind cone, and permit you to gain a missile shot position later.

g. Frequently it is better to roll to dissipate angle off or lateral separation than to use a combination high yo-yo, low yo-yo. The barrel roll or roll-off allows the F-4 to retain a higher energy level and often places the F-4 in the enemy's blind cone.

COCKPIT CHECKS

(U) To assure the highest probability of success for any air combat situation, the F-4 fighter aircrew should thoroughly check and optimize their aircraft and weapons system for the air-to-air engagement.

(U) POST TAKEOFF CHECKS

a. The aircraft should be trimmed in level flight at 400 KCAS and the RIO should note the aileron and spoiler positions. Place the radar in OPR and select PULSE mode, NAR/NORM speedgate, GYRO IN (NORM), and 5/10 nautical mile range. The pilot should check that the missile power switch is in STBY, the missile arm switch is in SAFE, and the AIM-9 coolant switch is ON/NORM. Proceed to check the aircraft rig and stab aug system for proper operation as follows:

Note

Delay wing fuel transfer until rig checks are completed to preclude the adverse effects of unequal transfer.

(1) Disengage roll aug. This action prevents the stab aug from countering the rolling moment induced by dihedral effect (rudder) at high angles of attack.

(2) Pitch Aug. With the aircraft trimmed for balanced flight at approximately 400 KCAS, pull 2G and then relax stick pressure. Pitch aug should dampen the displacement within one-half cycle.

(3) Yaw Aug. With yaw aug engaged, deflect the slip indicator ball one ball width and then release. Yaw should dampen within 5 seconds.

b. Maneuver the aircraft in the section to place the wingman in a 0.5 to 1 nautical mile trail. With 35 mils set on the gun sight, the trailing aircraft aircrew should initiate a radar lockon utilizing VTAS, PLM, or boresight techniques by the RIO. The pilot should also check the scope presentation.

c. Place the missile/weapon select switch to HEAT/SW and check the SW light, audio tone, and seeker null position for each AIM-9 being carried. The pilot must ensure that he notes any missile with a degraded tone or offset null. Check that the heat dot is aligned with the gunsight pipper set at 35 mils. The AIM-9 ASE circle is 42 mils in diameter. With the heat dot inside the circle, the bogey must be within the gunsight reticle (50/60 mils in diameter).

WARNING

Ensure that the missile arm switch is in SAFE.

d. At a range of 1 nautical mile descend 300 feet and check the position of the heat dot. It should be 3° high. Select RADAR/SP, descend, and note the position of the target when the radar elevation strobe indicates the target is 30°, 40°, and 50° high. Also note the position of the target when the elevation strobe pegs. These target position points should be noted and remembered since they are convenient references for the pilot when he is coaching the RIO for a radar lockon in ACM. The RIO should also note the elevation strobe position at the point where he loses sight of the target as it travels from 12 o'clock high on the canopy to the nose.

e. Maneuver to switch positions with your wingman while checking fuel transfer and setting the jettison switches. For efficient use of time, the leading aircraft aircrew should be performing the rig check while the trailing aircraft aircrew is performing the target elevation and AIM-9 tone checks.

f. Following is a typical UHF call upon completion of the checks:

EASY TWO, CHECKS COMPLETE, WEAPONS SWEET
EASY ONE, SAME

(U) PRECOMBAT SWITCH SETTINGS

(C) It is imperative that the weapon switches be set to the proper position for every flight, particularly the missile/weapon select switch, and that the proper switch settings for a missile launch be selected as early as possible. To preclude inadvertent mispositioning of the missile switches, a systematic checklist should be utilized by the pilot and challenged by the RIO. On F-4J with cockpit optimization, a different checklist is required since many of the controls and indicators are redesigned and relocated to optimize operations in an ACM environment. Modifications in the front cockpit include: installation of a new air-to-air panel with redesigned controls; installation of weapon select and target acquisition enable controls on the control stick; redesigned and relocated missile status panels; installation of a heads-up weapon status panel; installation of SHOOT and SEAM lockon lights; and weapon light reset provisions. Modifications in the rear cockpit include: installation of a fuel gauge, angle of attack indicator, and radiation hazard lights on the main instrument panel; relocation of the radar set control panel and switch function changes; relocation of the antenna hand control; and installation of heads-up weapon status lights including a SHOOT light. Before entering a hostile area, the following switch selections and checks are recommended:

PILOT (Pre-engagement)

F-4B/N and F-4J before cockpit optimization

CW power - ON
Interlocks - OUT (DOGFIGHT some aircraft)
VTAS mode - VTAS (some aircraft)
VTAS power - ON (some aircraft)
Loaded AIM-9 station - SELECTED
Coolant - ON
AIM-9 audio tone - CHECK
Missile select - RADAR
Missile arm - ARM
Sight - 35 MILS
External tanks - EMPTY
Internal tanks - SELECTED
Bomb control - DIRECT
Centerline station - READY (if centerline store is aboard)
Weapon switch - CONV OFF-NUCL ON

F-4J with cockpit optimization

CW power - ON
Interlocks - OUT/DOGFIGHT
VTAS mode - VTAS
VTAS power - ON
Desired AIM-9 - SELECTED
Coolant - NORM
AIM-9 audio tone - CHECK
Weapon select - SP
Desired AIM-7 - SELECTED
Gun/missile arm - ARM
Sight - 35 MILS
External tanks - EMPTY
Internal tanks - SELECTED
Jettison select - AIR-GRD+CL

(Engagement)

Jettison MER/TANKS

(C)

RIO CHECKLIST

a. Radar switches -

(1) Gate switch - NAR (F-4B/N)/NORM (F-4J)
G switch (some F-4J) - NORM
(2) Power/function - OPR

b. ECM - AS BRIEFED (refer to secret supplement)
c. Circuit breakers -

(1) Check circuit breakers - IN
(2) Eject and motor fire circuit breakers - CHECK

Note

- When engagement is imminent (visual sightings and/or radar contacts), the flight leader should call SWITCHES ARMED to ascertain that all flight members have cw power ON and the missile arm switch in ARM. On F-4B/J before removal of pseudo tuning, the missile arm switch should be returned to SAFE after the engagement or positive friendly identification. There is a possibility that an AIM-7 missile could detune, with no indication to the pilot, if the missile arm switch is left in ARM for an extended period of time. On F-4N and F-4B/J after removal of pseudo tuning, the missile continues to tune in ARM. However, if a firing attempt has been made, on F-4B/N and on F-4J before cockpit optimization the missile arm switch should be cycled through SAFE to return any trapped out missiles that are tuned to the firing sequence. On F-4J with cockpit optimization, locked out missiles that are tuned may be selected with the weapon select switch.

- The NAR/NORM speedgate must always be selected. If WIDE speedgate is used, AIM-7 success will be marginal due to late speedgate locks and possible acquisition of chaff or main lobe clutter. In modes that do not provide range rate, the system automatically switches to wide sweep.

(C) In the AN/APQ-72, selecting OVRD with the clutter switch inhibits PLMS, thus preventing loss of range track during bogey high-G maneuvers. However, this increases the range tracking circuit susceptability to a lock transfer to the altitude line because of the wide tracking gate. The range tracking circuit acceleration limit for the AN/APG-59 in the PD and pulse modes is always 3.5G regardless of radar switch settings. On F-4J with 1527 configuration radar sets, either a low or high-G acceleration limit may be selected for the pulse range track circuits with the G switch. LOW selects a 3G acceleration limit. NORM approximately doubles the pulse range track acceleration limit to 6.7G (high-G acceleration limiter). The high-G acceleration limiter is automatically selected when the pilot utilizes the PLM or VTAS/RADAR mode or when the AIM-7E-2 dogfight mode is manually selected. The G switch should remain in NORM unless chaff is anticipated or encountered.

(C) The missile load will be governed by the enemy threat and operational considerations such as missile availability and landing weights. A load of four AIM-7 and four AIM-9 missiles may be desirable in a high threat area; while in a low threat area, two of each missile types may be considered more practical. External fuel tanks will normally be carried and should be jettisoned before engagement. While external wing tanks can be jettisoned with movement of only one switch, the centerline tank requires proper positioning of three switches. In hostile territory, some time may be saved by having the bomb control switch in DIRECT, the weapon switch in CONV OFF-NUCL ON, and the centerline station switch in READY. Only the bomb pickle need be pressed to jettison the centerline tank. On F-4J with cockpit optimization, the external stores emergency release button may be utilized in conjunction with the jettison select switch on the air-to-air panel to jettison selected stores (selective jettison provisions). Placing the jettison select switch to AIR-GRD selects all stores for jettisoning except air-to-air missiles and any store carried on the centerline station. AIR-GRD+CL selects all stores for jettisoning except air-to-air missiles. In either AIR-GRD or AIR-GRD+CL, some armament attachments are retained when they are carried in combination with air-to-air missiles on the inboard wing pylons. Refer to External Stores Jettison Chart, NATOPS Flight Manual, NAVAIR 01-245FDD-1.

Note

Placing the jettison select switch to ALL selects all stores for jettisoning including air-to-air missiles.

FIGHTER VERSUS FIGHTER MANEUVERING

(U) GENERAL

(U) In the following discussion of fighter versus fighter maneuvering, the case system will be used; i.e., hypothetical situations which a pilot may encounter in airborne combat. In order to gain a good understanding of basic fighter maneuvering, a detailed discussion is provided. The maneuvers are presented in four categories.

a. One versus one offensive maneuvering
b. Engaged maneuvering
c. Defensive maneuvering
d. Last ditch maneuvering

(U) THEORY OF MANEUVERING

(C) Effective air combat tactics define the optimum means of maneuvering into the weapons firing envelope of the attacking fighter. The desired firing position within this envelope dictates the offensive maneuvering to be utilized by the fighter. For the F-4, the dead 6 o'clock position at 1 mile range approximates the optimum firing position for the AIM-9D or the AIM-7E-2. The maneuvering required to gain this position is dependent upon turn performance capabilities (rate and radius as a function of velocity and available G), acceleration, and use of the vertical. The recommended method of attack for the F-4 against low wing loaded bogeys is the high speed slash attack maneuver to the heart of the ACM missile envelope. The extensive lead pursuit attack used by tighter turning, guns-equipped fighters is not recommended for the F-4 as this type of an attack results in the loss of nose-to-tail separation and an eventual overshoot.

(U) To acquire an understanding of fighter versus fighter combat, the relationship of the factors involved must be understood. Calibrated airspeed at a given altitude and the pilot's use of available G determines the maneuvering envelope. The pilot has complete control over velocity and can maneuver to effectively use the effect of 1G gravity in a given tactical situation. Refer to Combat Performance Charts, this section, for detailed discussion of gravity effect on turning performance. Examination of the loop maneuver shows that the aircraft will turn shorter when inverted, provided speed is not increasing. Thus, the size and shape of the field of maneuver is determined by the effect of 1G gravity and the performance limitations of the aircraft. This field is egg shaped (figure 1-3). It is extremely important to fight a relatively high energy fighter such as the F-4 in the vertical plane utilizing the full field of maneuver shown in figure 1-3.

FIELD OF MANEUVER

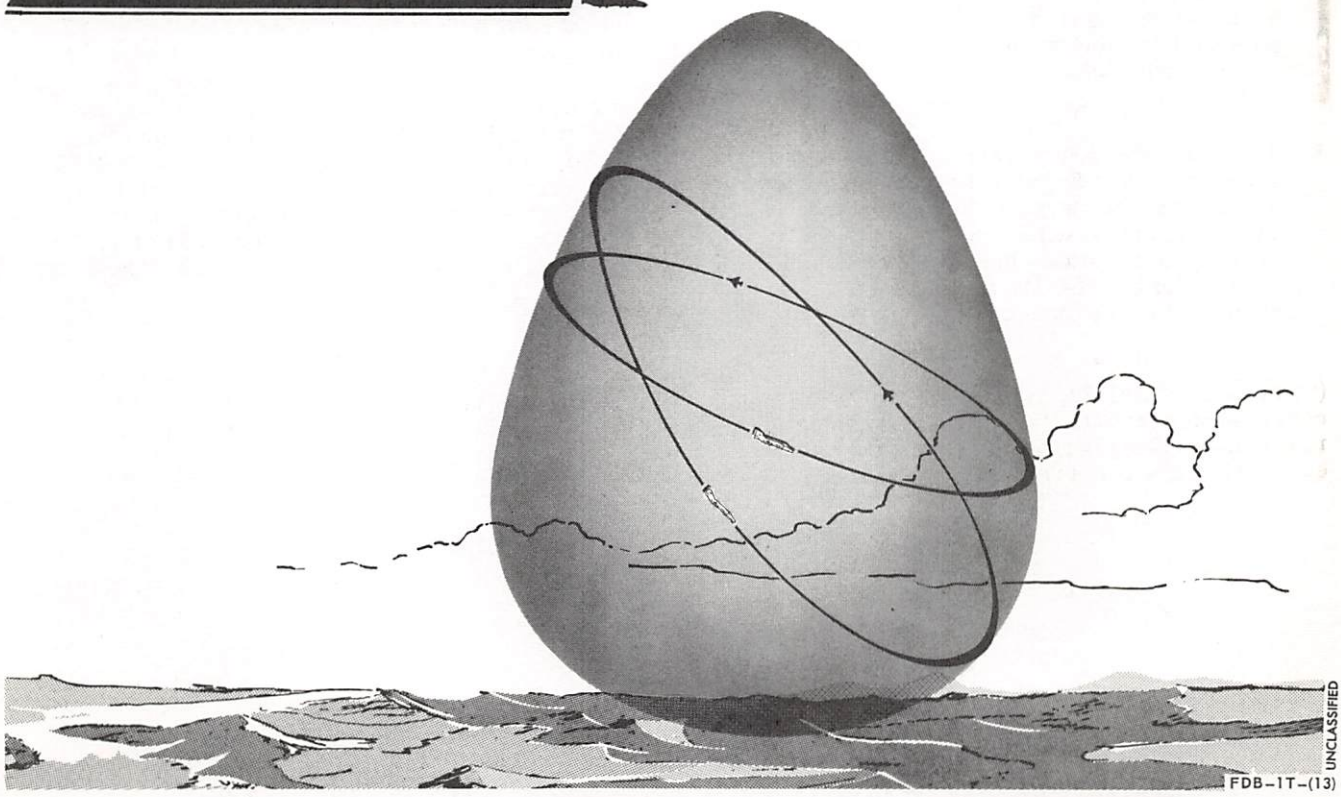


Figure 1-3 (U)

(U) ONE VERSUS ONE OFFENSIVE MANEUVERING

(U) The following maneuvers are presented to improve your understanding of traditional tactical maneuvers. These offensive maneuvers will be used extensively by low wing loaded aircraft. Not all of these maneuvers are recommended for the relatively high wing loaded F-4 and are so noted as appropriate.

(U) LAG PURSUIT

(C) Essential to successful F-4 maneuvering is the concept of lag pursuit. During sustained maximum performance turning, an attacker that is pulling lead (for a gun attack) is established on a smaller turn radius. If co-speed, in the same type aircraft, he is pulling more G and closing. However, if he is maintaining a lag position (nose behind the defender) and at co-speed, less G is necessary.

(C) An F-4 attacking a low wing loaded aircraft can establish a lag tracking position with resultant higher speed and G available than the defender. This position places the F-4 on a larger turn radius but at a roughly equal turn rate. Obviously the position does not allow a gun attack or an immediate AIM-9 attack. It does accomplish the following:

a. It allows the F-4 to remain offensive against a low wing loaded aircraft.

b. It places the F-4 in or near the defender's blind cone.

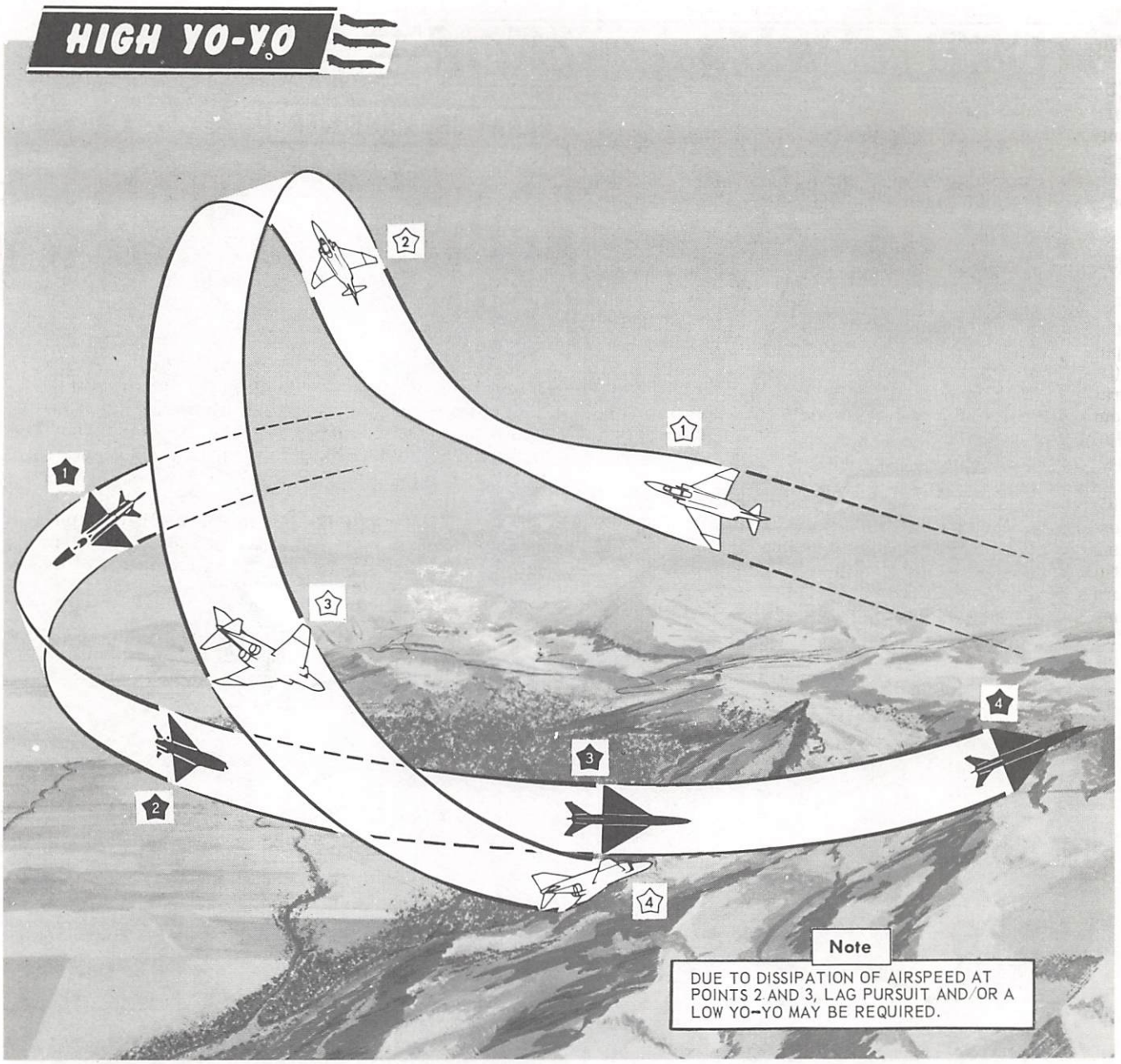
c. It allows the F-4 to retain a high energy level.

d. A radar lockon is possible when in lag pursuit. The bogey will normally be stabilized approximately 30° -35° high at 12 o'clock and can be held there until the radar time delays have elapsed. A shot possibility then exists if you can pull the bogey to the nose.

e. On aircraft with SEAM, the pilot can lock an AIM-9G/H missile on a bogey whenever it is within 20° of the nose. Locking the AIM-9G/H on the target does not preclude firing outside the normal AIM-9 launch envelopes but it does ensure the AIM-9 is fired with tone.

(C) The lag pursuit position is normally 3000 - 6000 feet from the defender. The target is positioned well above the F-4 optical sight and frequently his fuselage underside or belly is visible. If the defender suspects an F-4 overshoot and/or has lost sight, he may reverse. This may afford the F-4 an opportunity to shoot as the defender is solving the tracking problem. If the shot is lost, to reestablish the pursuit position, roll or pull to the outside and then reverse. Lag pursuit attack is a basic tool of F-4 maneuvering.

(C) Against a bogey that sees you in an offensive position, you will use combinations of lag pursuit, pure pursuit, and even lead pursuit to force the bogey into turning in a desired direction (or rate).



The high yo-yo is an offensive maneuver in which the F-4 maneuvers through the vertical and horizontal planes to prevent an overshoot in the plane of the enemy's turn. An overshoot can be generated by (1) too much angle off or (2) excessive overtake, or a combination of both. When the overshoot appears imminent, the F-4 should roll a quarter turn away and pull up into the vertical plane (1). This allows nose-tail separation to be maintained. Afterburner may be employed as required to maintain closure.

After starting the pull-up, the F-4 should keep the nose coming up and roll toward the enemy to keep him in sight. At the slower speed in the apex (2), the F-4 should pull his nose back down through the horizon to realign with the enemy's six o'clock position (3). The F-4 must avoid attaining an excessive nose-low attitude when realigning with the enemy's six o'clock. Recovery from this attitude is difficult and the enemy may force the F-4 into a defensive situation by pulling up into the attack.

UNCLASSIFIED

FDB-1T-(14)

Figure 1-4 (U)

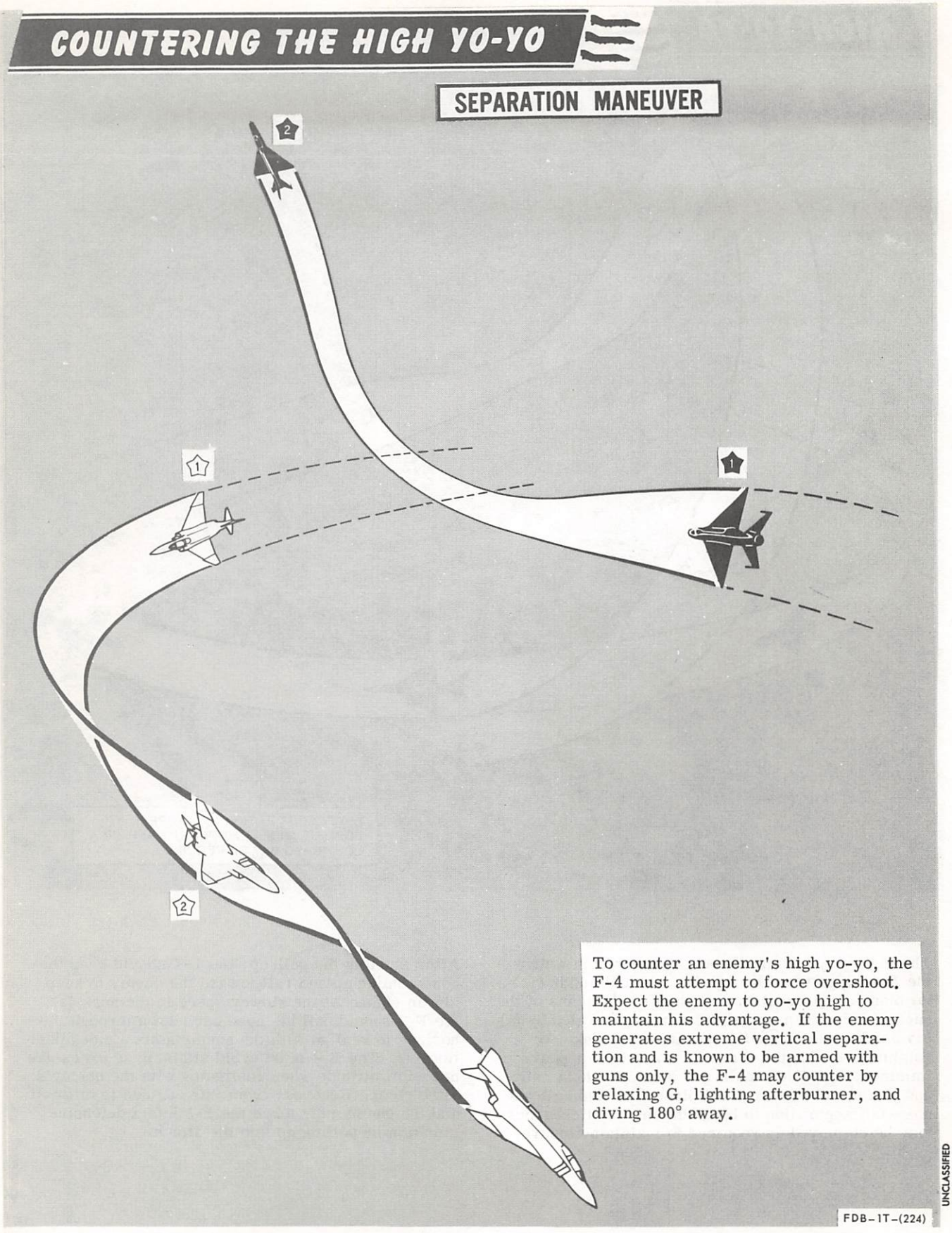
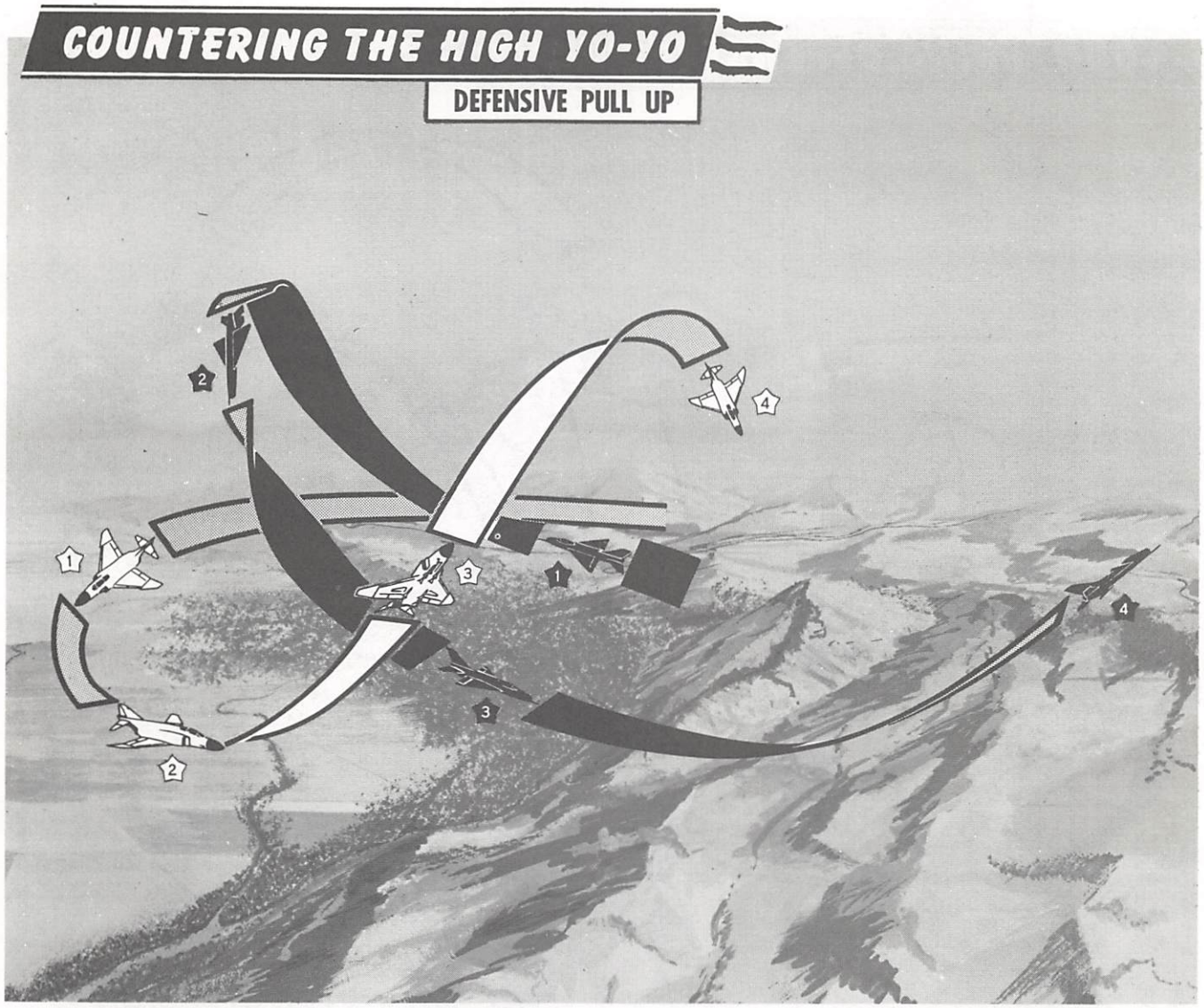


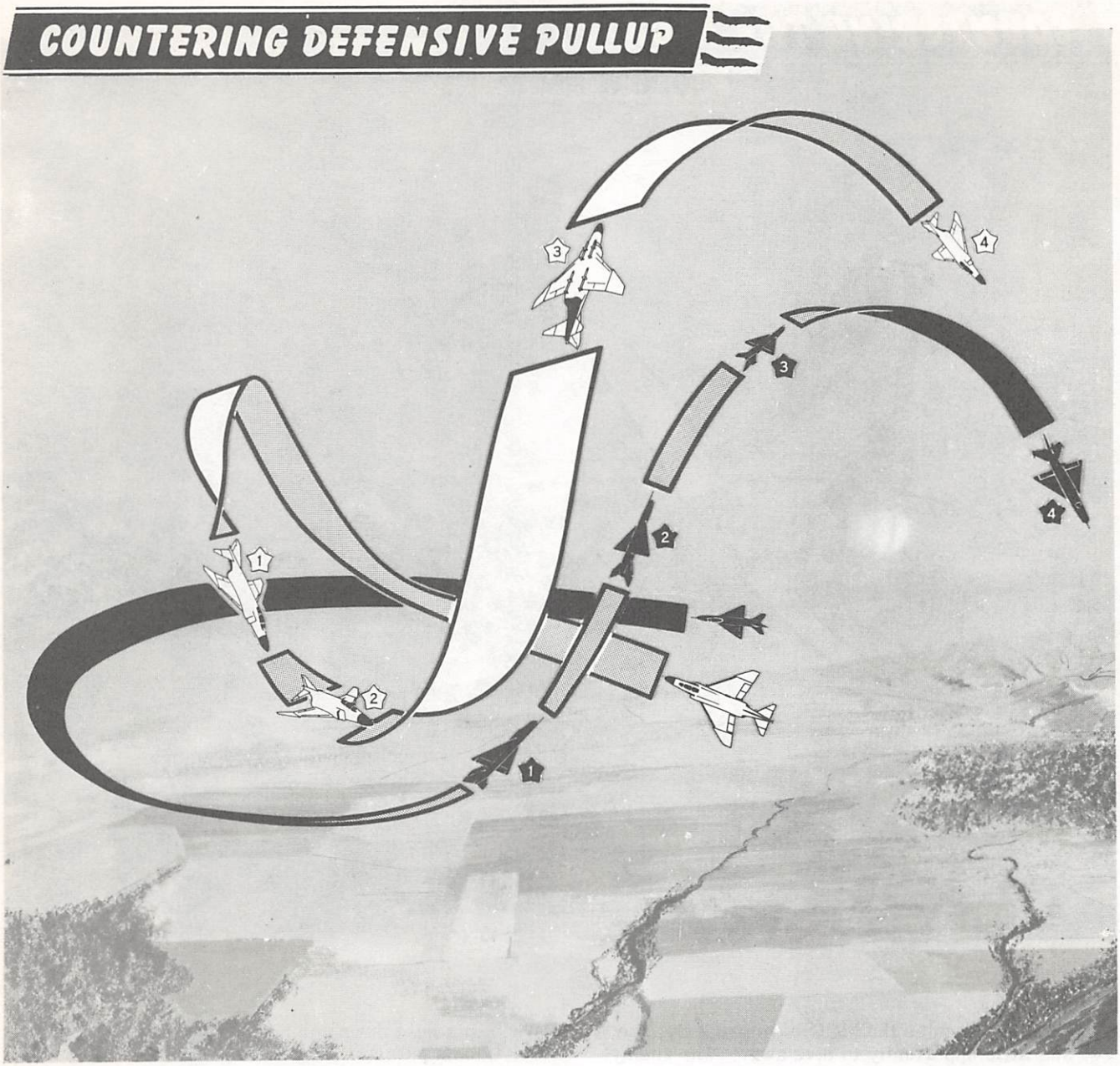
Figure 1-5 (U) (Sheet 1 of 2)



If the enemy executes the high yo-yo properly, the F-4 has little opportunity to dive away. The enemy, although in a most favorable position, is not set up in the F-4's lethal cone. The F-4 should relax G to gain energy when the enemy yo-yo's off (1) and, at the same time, maintain angle of bank. As a result, the nose will drop slightly below the horizon. If the enemy commits himself to press the advantage, he will drop his nose and attempt to set up for the attack. When this nose down commitment is observed, the F-4 should pull up into the attack (2). If the F-4 waits for the commitment and counters correctly, the enemy will be placed in a nose-low attitude, while the F-4 has a nose-high attitude (3). This may force the enemy into an overshoot, below and forward of the F-4's line of flight. To gain the offensive, the F-4 must roll-off to the enemy's six o'clock position (4).

UNCLASSIFIED
FDB-1T-(15)

Figure 1-5 (U) (Sheet 2 of 2)



In this situation, the F-4 has performed a high yo-yo to prevent an overshoot and the enemy has countered with a defensive pull-up. To successfully maneuver against the enemy's pull-up, the F-4 must maintain nose-tail separation by turning in a plane away from the enemy's turn. The F-4 should roll one quarter away from the enemy's line of flight at the instant he observes the enemy's rolling pull-up (1). At the same time, he should begin a smooth pull-up behind the enemy's line of flight. The F-4 should play his pull-up so that he does not overshoot the enemy's original altitude (2). (An overshoot here would be the same as an overshoot in the horizontal plane before executing the high yo-yo.) If the enemy continues his pull-up, the F-4's higher energy level enables him to zoom above (3) and roll behind the enemy (4).

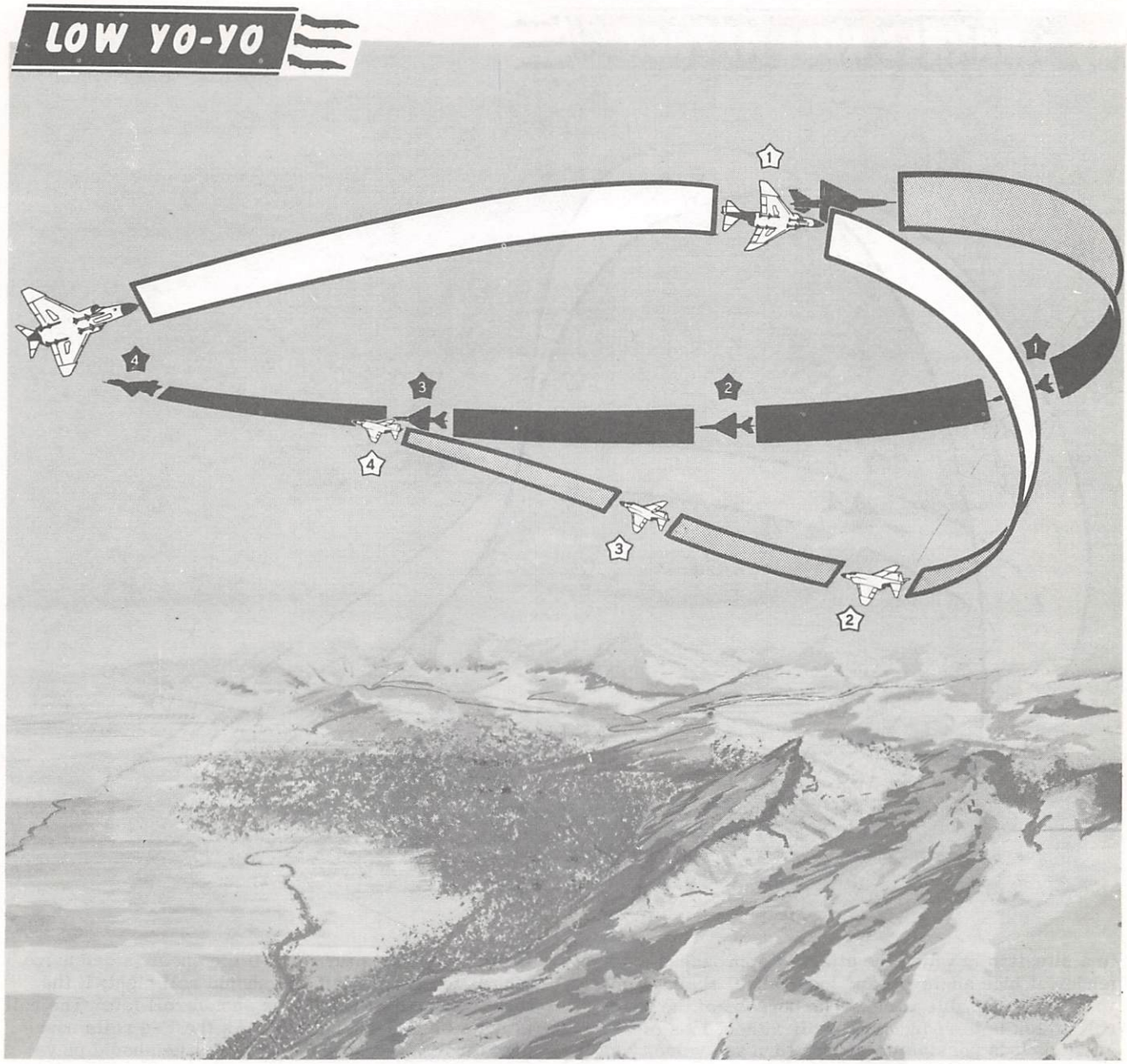
Note

When executing a high yo-yo- due to excessive angle off and with approximately the same energy level, the enemy's defensive pullup will make the situation right for an entry into a rolling scissors.

UNCLASSIFIED

FDB-1T-(16)

Figure 1-6 (U)



The low yo-yo is an effective offensive maneuver that is used to decrease range or increase rate of closure. To begin this maneuver, the F-4 should lower his nose, start to the inside of the enemy's defensive turn, and light afterburner (1). The horizontal turn radius will decrease, the range will close, and speed will increase. The F-4 should terminate afterburner (2), round out with enough speed to complete the zoom, and then relight the afterburner once the nose-up attitude is established (3). This maneuver can be repeated as required to close to firing range.

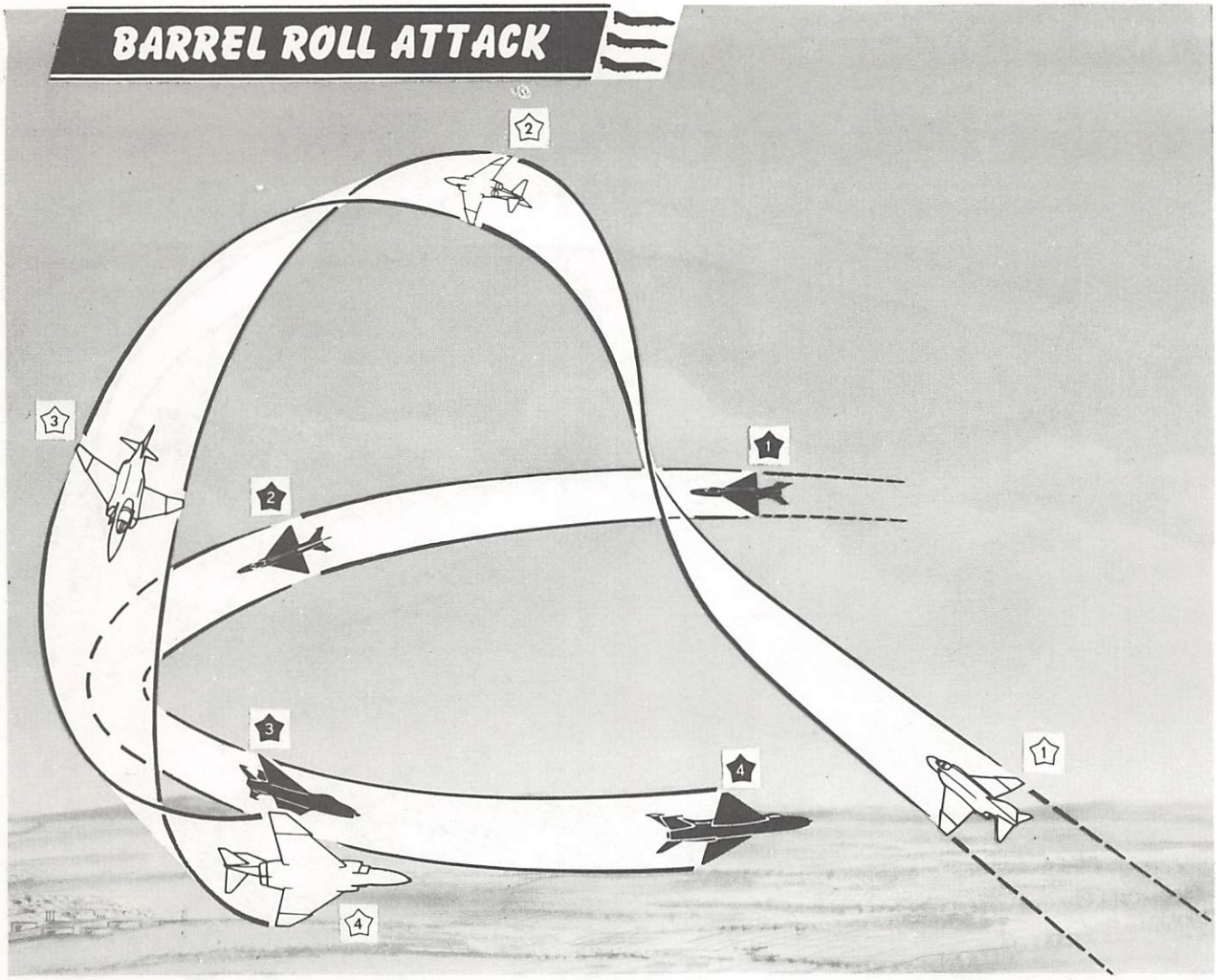
COUNTERING LOW YO-YO

When slower than 400 knots CAS, the F-4 should counter the low yo-yo by diving into the attack the instant the enemy starts his maneuver, in an attempt to meet him head-on. If an immediate turn-in is not made, the enemy will rapidly reduce angle-off and range. If the F-4 has maneuvering airspeed (in excess of 400 knots CAS), he should pull up and roll into the enemy, executing a vertical barrel roll to the enemy's six o'clock high position.

UNCLASSIFIED

FDB-1T-(17)

Figure 1-7 (U)

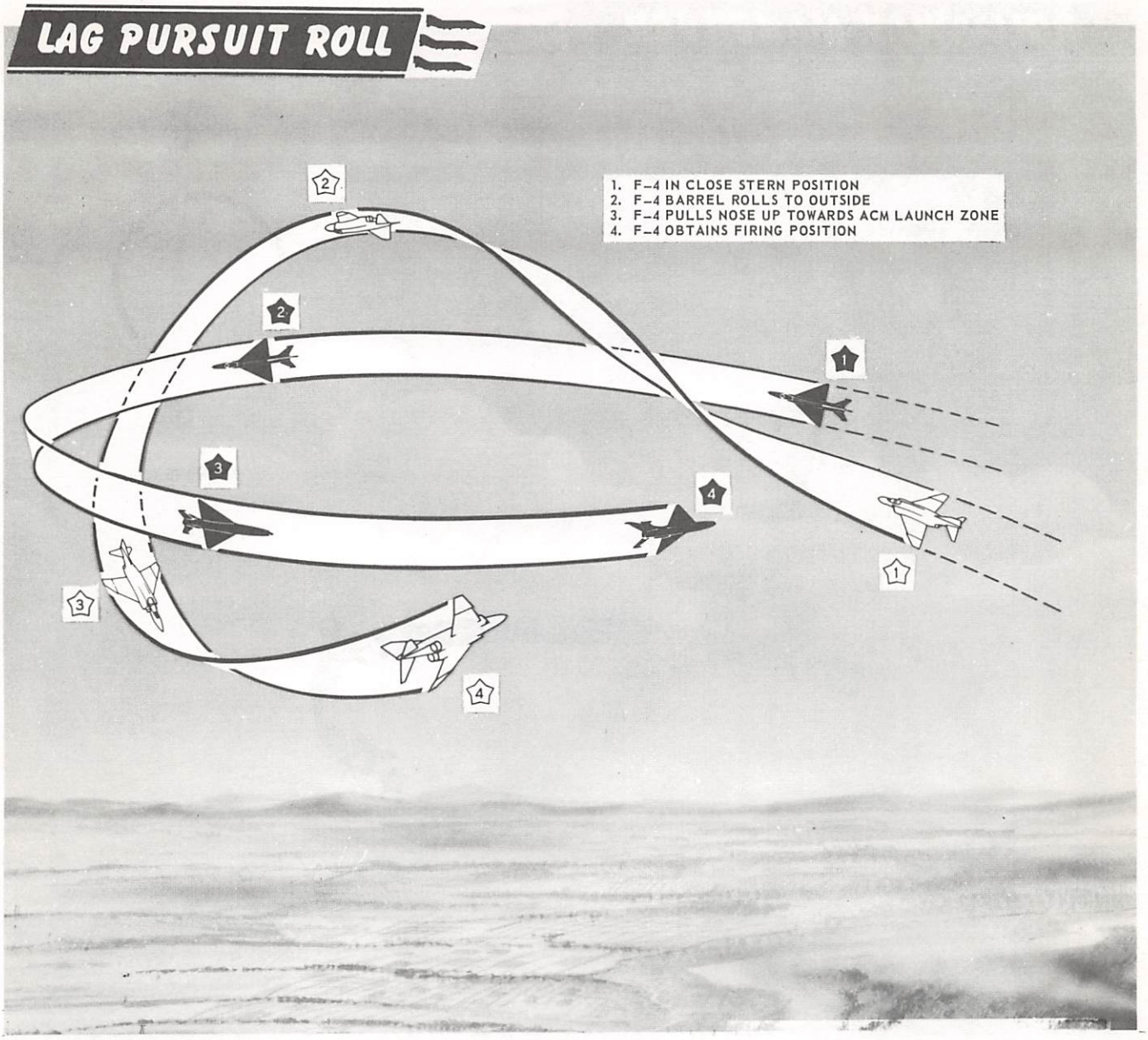


In a situation in which the attacker approaches a defender at high angle-off and long range, the high yo-yo has questionable value. The purpose of the barrel roll attack is to reduce angle-off without loss of energy. It is possible to reduce turn and velocity by two methods: (1) through both the vertical and horizontal planes by employing a two-dimensional maneuver (yo-yo), or (2) maneuver through both the vertical and horizontal planes by employing a three-dimensional maneuver (barrel roll). Thus far, the emphasis has been on the first method. Now both methods will be employed to reduce angle-off. If the F-4 approaches the enemy from below and at a high angle-off, he continues to cut off, in an attempt to reduce angle-off, until he reaches his pull-up point. The F-4 should pull up well inside the enemy's defensive turn (1), then barrel roll in a direction away from the enemy's turn (2). If the enemy's defensive turn is toward the left, he should roll right; if the turn is toward the right, he should roll left. The roll is not a high-G-barrel roll. As the F-4 rolls nose-high through the inverted position, he should play back pressure and rudder to obtain a nose-low 270° change in direction (3). During this portion of the maneuver (from the inverted position to the 270° point of roll), the F-4 receives the benefit of 1G gravity, which assists him in gaining a rapid change of direction toward the enemy's six o'clock position. If the F-4 has made the entire maneuver (from pull-up through the roll) without an overshoot, he will be above, at a reduced angle-off, and in a position to dive below the enemy's line of flight for a six o'clock low position (4). Lag pursuit techniques can be used to retain the offensive.

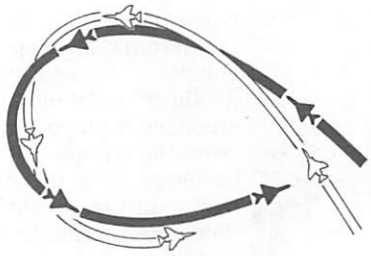
UNCLASSIFIED

FDB-1T-(18)

Figure 1-8 (U)



(1) If a stern position is gained inside missile minimum range, a variation of the barrel roll attack can be used to retain the offensive. To initiate it, pull up and start to roll to the outside, rolling rapidly through the inverted position. (2) A nose low pitch attitude in excess of 40° from the enemy's plane of action should be avoided, since it will normally take too long to raise the nose back to firing position. (3) Continue to pull the nose up to reach the launch zone firing position. (4) This maneuver, usually produces a firing position off the enemy's tail, looking up, at about 1 mile. Unless the aircraft is equipped with SEAM, the AIM-7 will usually be employed (if previously locked up) since AIM-9D tracking time is minimal. With SEAM an AIM-9G/H shot possibility also exists by utilizing the expanded field of view or possibly locking the seeker on the target. If the enemy reverses at the apex of the roll, continue the roll around his flight path through another 270°, and use lag pursuit techniques.

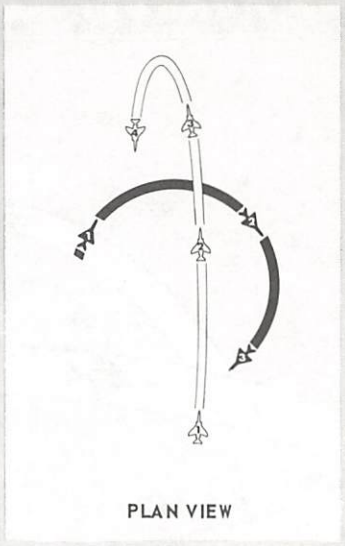


PLAN VIEW

CONFIDENTIAL
FDB-1T-(19)

Figure 1-9 (C)

ROLL-AWAY MANEUVER



When fighting an enemy aircraft with a definite advantage in turn performance maintaining any type of lead pursuit curve for a prolonged period will be impossible. In these instances lag pursuit maneuvering becomes very effective. As the F-4 detects an overshoot developing (1), rather than executing a standard high yo-yo, an effective maneuver is to begin a yo-yo but roll away from the enemy (2). The rate of roll should be just enough to keep the enemy in sight. This technique will place the F-4 above, behind, and outside the radius of turn of the enemy. Very often, the enemy will lose sight of the F-4. (Such a situation is usually readily apparent and should be exploited by remaining out of sight as long as possible and attacking with relative impunity.) If the enemy continues his turn, as the F-4 rolls and climbs to keep him in sight, (3) a nose-down (modified split-S) attack should be initiated. If the enemy reverses his turn, the yo-yo will have to be taken higher and the attack delayed until sufficient separation is generated.

CONFIDENTIAL

FDB-1T-(20)

Figure 1-10 (C)

(U) ENGAGED MANEUVERING

NEW (C) Engaged maneuvering allows the F-4 to repeatedly maneuver against a properly flown fighter of superior turning capability.

(U) HEAD-ON PASS

(C) Meet the bogey with minimum lateral separation (down to 100 feet) and maximum possible energy, jinking as necessary to spoil a guns tracking solution. Inform the RIO which side the bogey will pass. With a minimum lateral separation pass, the pilot, and possibly the RIO, will momentarily lose sight of the bogey at the instant of passing. Turn into the bogey to reacquire visual contact (e.g., bogey passes down the right side, turn right to reacquire). There are two basic methods which may be utilized to gain the advantage or a kill in subsequent maneuvering after the head-on pass. They are (1) an extension and a vertical reversal (pitchback) or (2) a slice turn. It is important to understand that the decision to maneuver with either method is based upon (1) keeping or regaining sight of the bandit after the pass and (2) noting the bandits plane of turn.

NEW NEW

(U) EXTENSION

NEW (C) The extension maneuver is utilized when the bogey is observed to turn horizontally or nose-low to re-engage. This acceleration/separation maneuver is designed to provide sufficient separation between the F-4 and the bogey to allow a vertical reversal and subsequent head-on pass with the bogey.

NEW NEW (C) To initiate an extension, stop the turn into him upon regaining sight, unload, and continue an acceleration (extension) away from the bogey with maximum power and both crewmembers keeping the bogey in sight. There are four basic "moves" the bogey can elect to use from a head-on pass. The corresponding F-4 counter - moves are shown and discussed in figure 1-11.

(C) The extension utilizes the F-4's high energy addition rates. Normal airspeeds on the extension are 550-650 KCAS at the F-4's optimum fighting altitudes. Once regaining sight of the bogey out of the head-on pass, keep the bogey near the pilot's aft visibility limit, turning into the bogey as necessary to prevent him from drifting into your blind cone. Ensure you remain unloaded and keep the bogey near your visibility limit to prevent arcing and maximize the rate of separation. The three common extension errors which result in arcing are shown in figure 1-12. Extend only far enough to come back and meet the bogey head-on with energy. Visual contact cannot normally be maintained beyond 2-1/2 miles with a nose or tail aspect.

(C) With the large amount of excess thrust available in the F-4, the ability to accelerate quickly is an important technique to master. Unloaded (zero G) acceleration is the most effective way to rapidly increase airspeed. At zero G the airplane is not generating lift and, therefore, induced drag (drag due to lift) is zero. This provides a maximum thrust-to-drag ratio. A common error is to initially push over to near zero G and then relax as the nose goes further below the horizon. This is due to several factors: pilot discomfort, hesitancy to get the nose too low, loss of visual contact with the bogey, etc. The optimum acceleration technique is to unload to zero G and keep one wing slightly down to retain visual contact with the bogey. Apply top rudder as necessary to prevent arcing of your flight path. As the airspeed builds, forward stick pressure must be increased to maintain near zero G. By accelerating properly, the F-4 can quickly open or close on the bogey and position for maximum utilization of available weapons. Remember, at 450 KCAS and 15,000 feet, you are only 15 seconds away from 1.2 Mach if you accelerate properly.

(U) VERTICAL REVERSAL (PITCH BACK)

(C) There are several types of pitch back techniques. The pitch back is performed after gaining enough separation to meet the bogey head-on. The proper delay time (required separation) is a function of many factors including energy level, type of extension used (i.e., low, high, level), type of reversal used, and the aggressiveness and performance of the bogey. The separation distance required to perform the pitch back is in excess of 2 miles. Several of these extension and pitch back maneuvers may be required. Do not anticipate a forward quarter AIM-7E-2 shot opportunity. The type of pitch back is a function of relative bogey position and energy. The oblique loop should be used if the pass is near level and at low altitude. The rudder reversal method might be used when large pitch angles are used during extension; i.e., using a noon sun for masking. Complete mutual support must be maintained during these engaged maneuvers. The UHF call PITCH BACK is used for the command call. Refer to Loose Deuce UHF Transmissions, this section.

(C) The oblique loop utilizes the high energy level generated during the extension. The objective is to reverse the direction of the F-4 in minimum time without giving the bogey a rendevous (arcing) turn. Pitch the nose up to the side you are watching the bogey and commence the oblique loop. Afterburner may not be required from the start of the loop until the nose goes once again below the horizon. You are utilizing the vertical to bleed off the excess energy needed for the extension and which is now a disadvantage for optimum turn radius/rate. A level turn reversal (come back) will produce an extremely large radius of turn, giving the bogey angle time to rendevous in a guns or missile cone.

Note

When performing an oblique loop against most enemy fighters, care must be taken to prevent arcing of your flight path. These fighters have such a large turning performance advantage that if arcing of your flight path occurs, the enemy may arrive in a gun tracking position at the top of your loop. NEW NEW

(U) LOW ENERGY REVERSAL

(C) If initial maneuvering results in a situation where the F-4 is nose high, below 450 KCAS, with the enemy at his 6 o'clock, then the optimum reversal would be nose down, in the plane of action. Ideally this maneuver should be commenced with no less than 400 KCAS. Roll the aircraft using rudder/aileron to place the bogey above your head (relative to your aircraft) and execute a maximum rate turn. In this slightly nose-down condition, the time required to effect a 180° heading change is under 15 seconds. If a nose down head-on pass is made, the F-4 will probably reach high Q (above 600 KCAS). In this position, particularly if the bogey rides high, the turn back should be delayed until the F-4 can climb (not a vertical zoom) to pull the bogey level and until the excess energy (anything above 500 KCAS) can be converted to altitude. Once the near level or bogey-low position is realized, an oblique loop pitch back may be commenced.

NEW NEW

(U) SLICE TURN

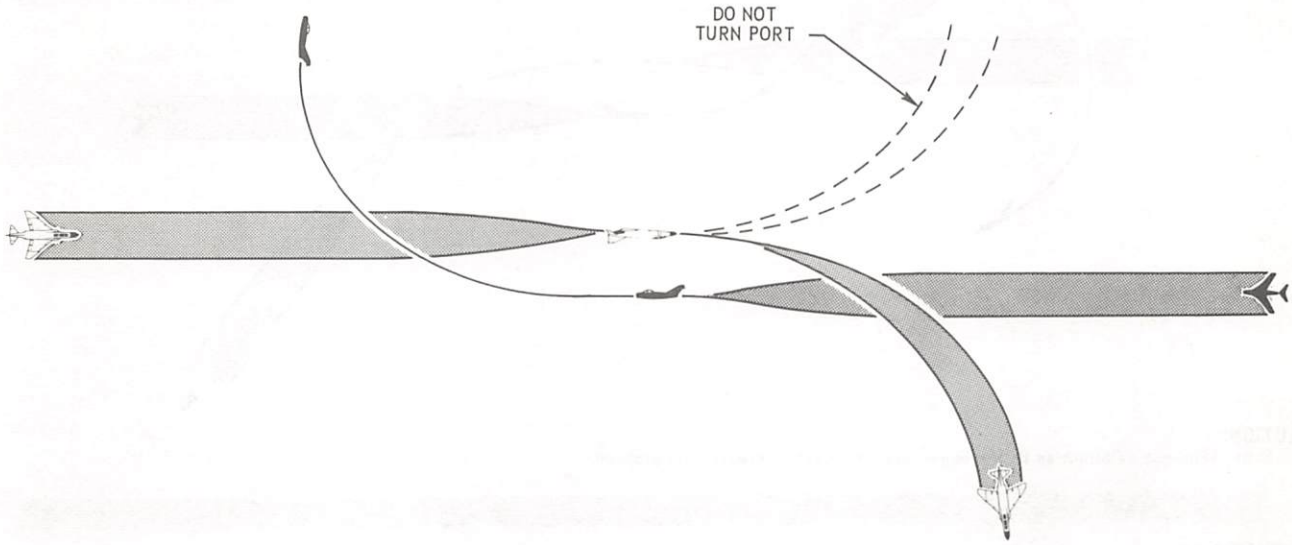
(C) A slice turn is utilized when the bogey is observed to use a nose-high turn in the vertical after the head-on pass. Commence a nose-low turn into the bandit, continue the roll to approximately 135° angle of bank, and proceed with a slice turn. As back stick pressure is applied, pull up to 16 units angle of attack or the structural limits of the aircraft. The RIO should position the antenna 30° up or higher. The RIO should be able to keep the bandit in sight throughout the maneuver until it moves from 12 o'clock high on the canopy to the nose. As soon as possible, the pilot calls the RIO to the radar. A forward quarter AIM-7 shot and a kill are the desired results. Once the nose-up attitude is attained, an unloaded zoom climb at a high energy level will result in a subsequent head-on pass. The bogey will generally be committed to an extreme nose-low attitude. This may be useful in gaining a position advantage as the F-4 maneuvers over the top. Attempts to maneuver into a close-in, slow-speed engagement should be avoided.

(C) Though the slice turn provides less total separation than the extension maneuver, it is a considerably faster method of re-engaging and provides an excellent opportunity to utilize the AIM-7 with a look-up angle. Although the nose-low turn optimizes sustained maneuverability and rate of turn, consideration must be given to the fighter's altitude above the terrain and possible AAA threats.

NEW NEW NEW NEW NEW NEW NEW NEW

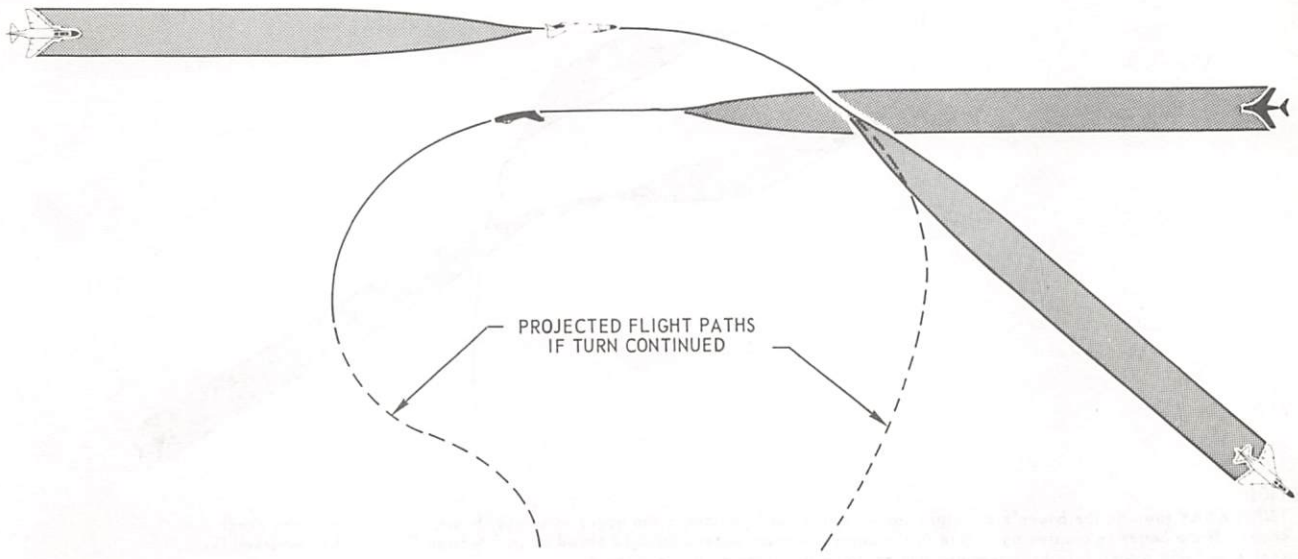
HEAD-ON PASS TECHNIQUES

SITUATION A:
Bogey passes down starboard side and turns into F–4.



ACTION:
Turn starboard to reacquire and continue to extend and turn as required to generate sufficient separation for pitch back and subsequent head-on pass with energy. This starboard turn forces the bogey into a hard turn (about 240°) and corresponding energy loss before getting the F–4 to his nose. A port turn initially by the F–4 would only require approximately 150° of turn by the bogey, with more bogey energy remaining and not as much separation generated.

SITUATION B:
Bogey passes down starboard side and turns away, realizing his smaller turn radius will give him the advantage if the F–4 continues starboard.



ACTION:
As you reacquire visual contact and see the bogey now turning into you, go wings level immediately and accelerate straight ahead. The bogey's radius of turn will allow you to keep him in sight throughout the extention. DO NOT TURN AWAY as you realize the bogey has elected this move.

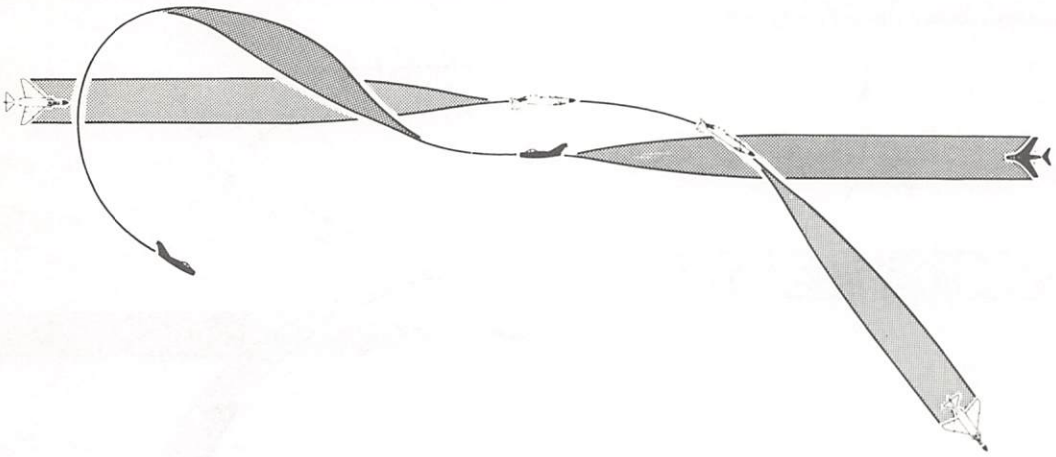
CONFIDENTIAL

FDB–1T–(21–1)

Figure 1-11 (C) (Sheet 1 of 2)

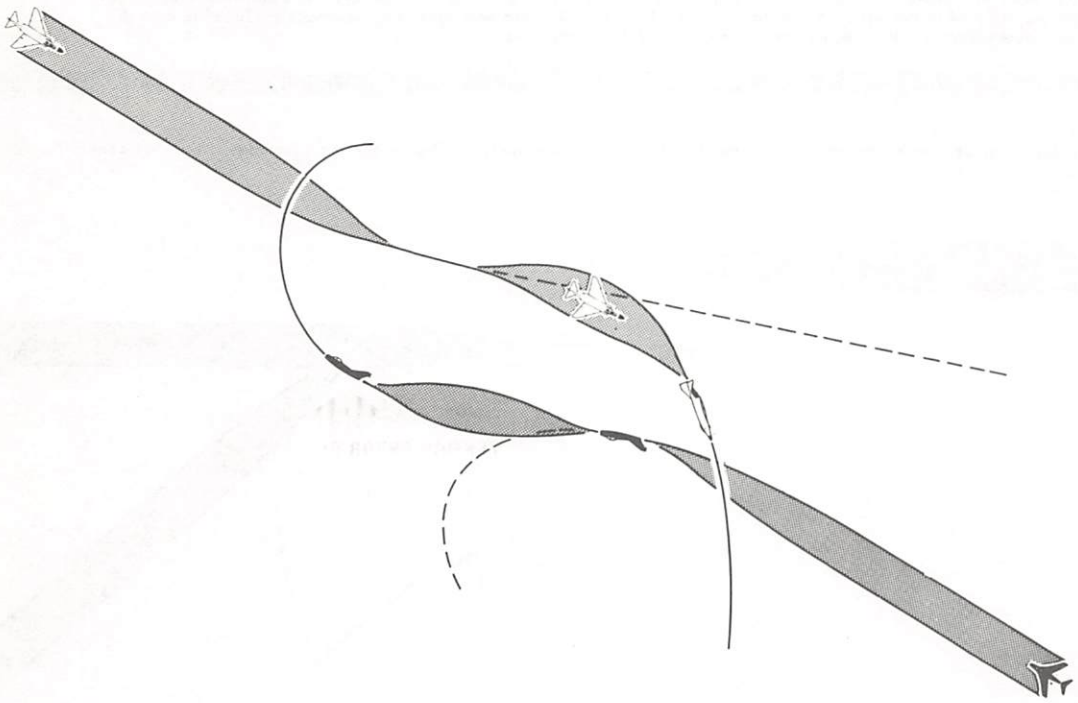
HEAD-ON PASS TECHNIQUES

SITUATION C:
Bogey passes down starboard side and turns into F-4 initially and then reverses as in Situation B.



ACTION:
Same technique as Situation B; the bogey has effectively increased his problem.

SITUATION D:
Bogey turns into/away prior to passing head-on, hoping the F-4 will continue straight ahead. This is common when the head-on pass is down hill into the bogey.



ACTION:
TURN AWAY towards the bogey's 6 o'clock, only turning until you sense the bogey is at your beam, then roll back and check the bogey. If the bogey is continuing to turn in the same direction, extend straight ahead as in Situation B. If he has reversed (by seeing you turn away), turn back into him and continue to extend as in Situation A.

Note

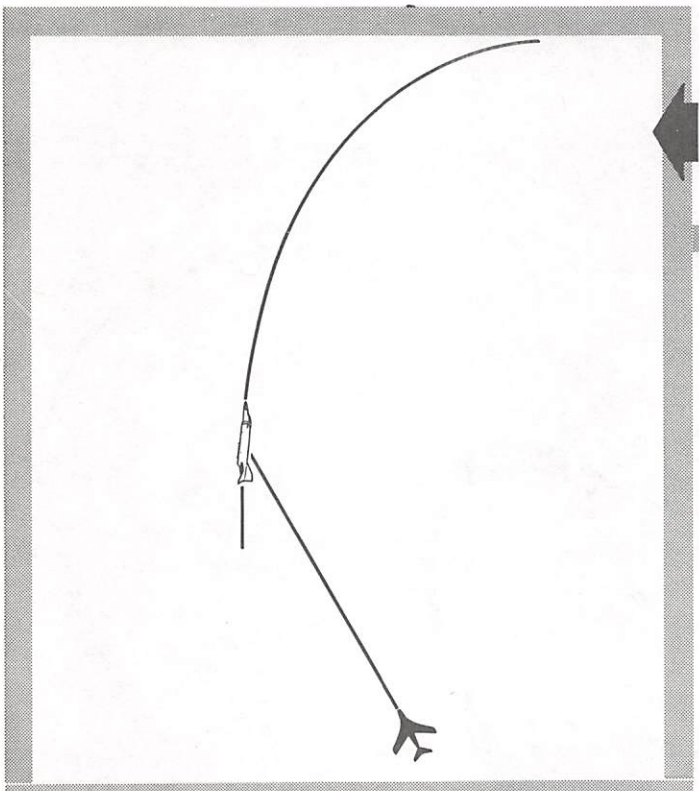
Tactical considerations in loose deuce maneuvering may dictate a deviation from these techniques to set up a kill for the free fighter.

CONFIDENTIAL

FDB-1T-(21-2)

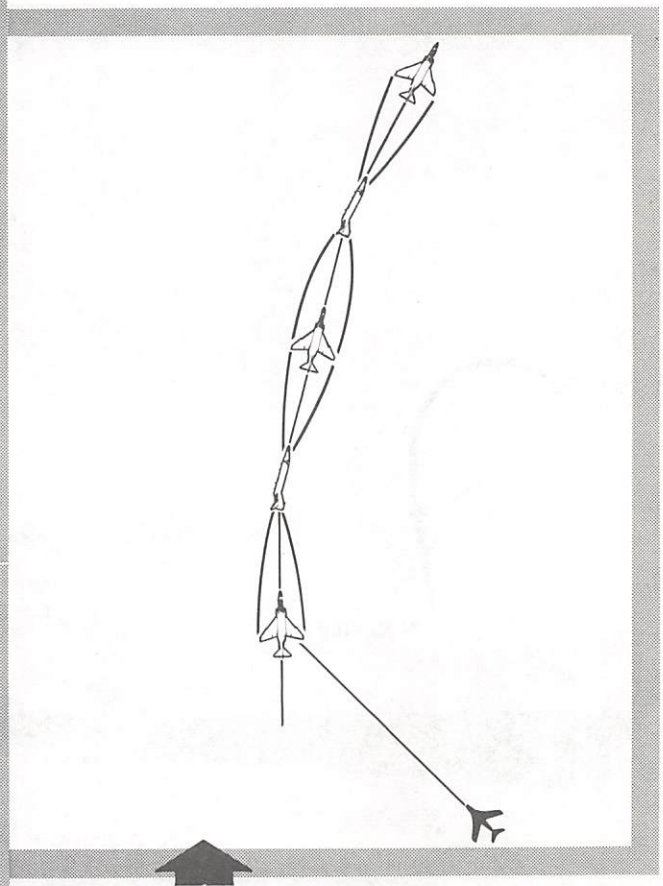
Figure 1-11 (C) (Sheet 2 of 2)

EXTENSION ERRORS THAT RESULT IN ARCING



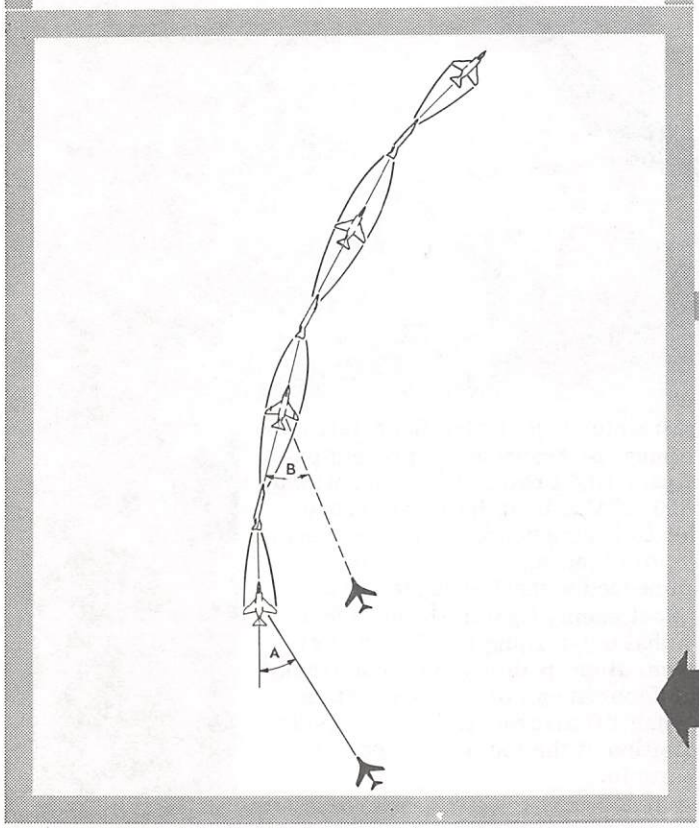
EXTENSION ERROR A:
Wing down, keeping the bogey in sight, but not completely unloaded, resulting in a continuous turn.

SOLUTION:
Leveling the wings after kicking the bogey out (in degrees) from your blind cone will preclude this.



EXTENSION ERROR B:
Proper technique with the exception that you are holding the bogey too far forward where the bogey can be comfortably seen.

SOLUTION:
Allow the bogey to drift farther aft prior to kicking him out.



EXTENSION ERROR C:
Proper technique except for kicking the bogey out in angle only a few degrees (angle B only 5° larger than angle A) forcing you to turn again very soon.

SOLUTION:
Kick the bogey out at least 15° to allow longer periods of extension. Example: Extension Error C can combine with Error B to cause extreme arcing.

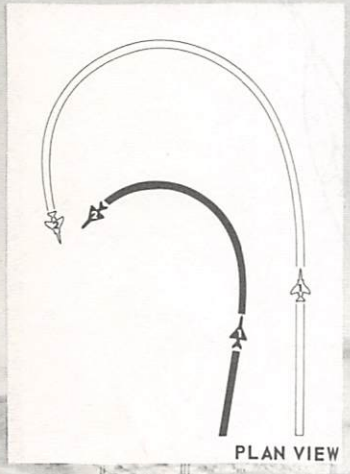
CONFIDENTIAL

FDB-1T-(22)

Figure 1-12 (C)

EFFECTS OF ARCING

1. F-4 PULLS UP TO COMMENCE AN OBLIQUE LOOP WITHOUT SUFFICIENT SEPARATION.
2. LOW WING-LOADED ENEMY AIRCRAFT OUT-TURNS F-4 AND GAINS A GUN TRACKING POSITION.

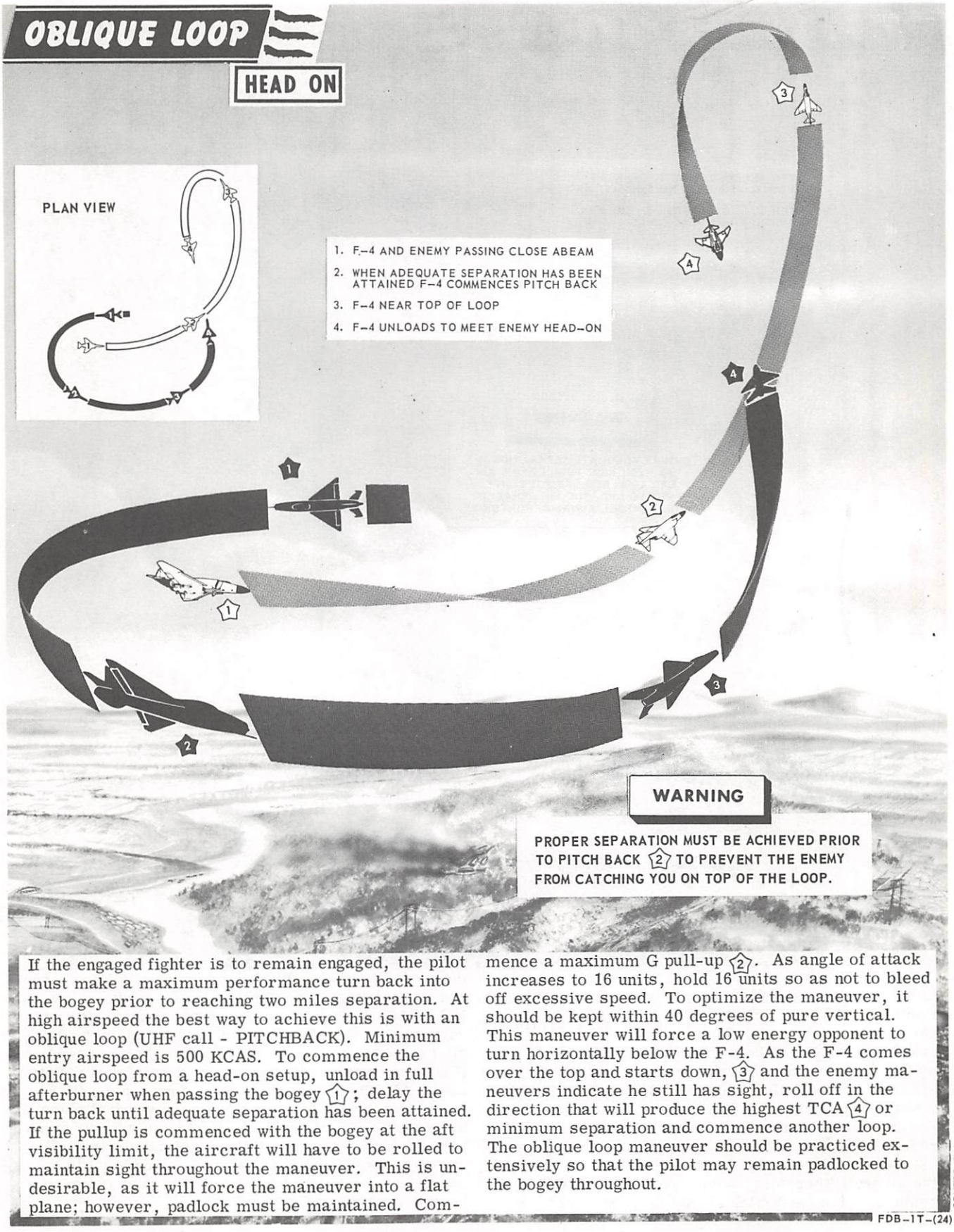


When fighting low wing-loaded aircraft which enjoy a significant turn advantage over the F-4, extreme care must be exercised to prevent excessive arcing (in any dimension) of your flight path. Although optimum turn performance is achieved near 450 KCAS, the pilot must ensure that he has sufficient separation prior to commencing an oblique loop, or other maximum performance turn, to re-engage or to meet the enemy head-on. An oblique loop commenced without at least 2 1/2 to 3 miles separation can be suicide. Most enemy fighters have such a large advantage in turn performance that out-turning the F-4 is easy and they can use turns or arcing of your flight path to gain a gun tracking position. Commencing an oblique loop without proper separation (1) will allow the low wing-loaded, high lift aircraft to fly well inside your turn and arrive in a tracking position at the top of the loop (2) where the F-4 is slow and very vulnerable.

CONFIDENTIAL

FDB-1T-(23)

Figure 1-13 (C)



If the engaged fighter is to remain engaged, the pilot must make a maximum performance turn back into the bogey prior to reaching two miles separation. At high airspeed the best way to achieve this is with an oblique loop (UHF call - PITCHBACK). Minimum entry airspeed is 500 KCAS. To commence the oblique loop from a head-on setup, unload in full afterburner when passing the bogey (1); delay the turn back until adequate separation has been attained. If the pullup is commenced with the bogey at the aft visibility limit, the aircraft will have to be rolled to maintain sight throughout the maneuver. This is undesirable, as it will force the maneuver into a flat plane; however, padlock must be maintained. Commence a maximum G pull-up (2). As angle of attack increases to 16 units, hold 16 units so as not to bleed off excessive speed. To optimize the maneuver, it should be kept within 40 degrees of pure vertical. This maneuver will force a low energy opponent to turn horizontally below the F-4. As the F-4 comes over the top and starts down, (3) and the enemy maneuvers indicate he still has sight, roll off in the direction that will produce the highest TCA (4) or minimum separation and commence another loop. The oblique loop maneuver should be practiced extensively so that the pilot may remain padlocked to the bogey throughout.

CONFIDENTIAL

FDB-1T-(24)

Figure 1-14 (C)

A rudder reversal can be effectively used to reverse into a low wing-loaded aircraft by accelerating to a minimum of 550 KCAS and using gradual G loading to establish a pitch angle. Then, unload and zoom for separation. (1) The height of the zoom is controlled by the altitude where afterburner is terminated. If airspeed decays below 350 KCAS do not attempt to reverse until below 220 KCAS and the rudder limiter is cut out. The turn should be made primarily with rudder. Due to the large amount of dihedral effect in the F-4, rudder inputs, by themselves, will only roll the aircraft; therefore, some opposite aileron will be required. Forward stick should be used to reduce the angle of attack. With proper control, the reversal can be comfortably performed at airspeeds as low as 100 KCAS. Reengage maximum afterburner after reversal (2) as the situation dictates. Keep the angle of attack low to regain airspeed as rapidly as possible. If the enemy falls off underneath, a brief opportunity for an AIM-9 shot may develop. However, caution must be taken not to overshoot in the vertical plane by pressing the attack too long. As the enemy begins to raise his nose back into the fight unload and roll away as much as possible without losing sight to gain separation for another rudder reversal or oblique loop.

CONFIDENTIAL

FDB-1T-(25)

Figure 1-15 (C)

(U)DEFENSIVE MANEUVERING

(C) The objective of defensive maneuvering is to prevent the attacker from reaching a firing position within his weapons system envelope. The F-4 aircrew must visually detect the attacker before he reaches his weapons system envelope and be familiar with the attacker's aircraft and weapons system performance. If a subsonic, guns only attacker is detected aft of the beam within 3 miles and closing, the F-4 should accelerate to provide sufficient separation to allow a vertical reversal and subsequent head-on pass with the bogey. If a supersonic, guns and missile equipped attacker is detected aft of the beam within 3 miles and closing, the F-4 will be unable to extend for sufficient separation to permit a reversal and head-on pass. Several alternatives are available to the F-4 aircrew:

a. An unloaded nose-low acceleration, while maintaining sight of the attacker may allow the F-4 to exceed the attacker's low altitude Q limit.

b. A climb into the sun may defeat the attacker's missile capability and/or cause him to lose sight.

c. A maximum power hard turn into the plane of the bogey to achieve angle off. If an overshoot can be obtained, continue the turn; if not, maintain angle off while keeping sight of the bogey and attempt to unload and regain energy while extending.

(U) LAST DITCH MANEUVERING

(C) When a bogey achieves a gun or missile firing position on the F-4, the pilot must apply his total experience and abilities into one or more last ditch maneuvers in order to save his life. For a bogey to arrive at this position, there must have been a breakdown in the normal flight integrity and mutual support concept. It does happen! In order for the pilot to quickly analyze the tactical situation and initiate the proper last ditch maneuver without hesitation, he must be mentally prepared before enemy engagement. Guidelines to follow when performing last ditch maneuvers are discussed in the following paragraphs.

(U) MISSILE THREAT

(C) Escape from air-to-air IR missile threats should be initiated by a break turn into the plane of the bogey to achieve angle off. Commence the turn in military power and hold this power setting until your IR source is sufficiently blanked, then afterburner may be selected. Once the proper angle off is achieved, relax G to a hard turn to preserve energy. If an overshoot can be obtained, continue the turn; if not, maintain angle-off while keeping sight of the bogey and attempt to unload and regain energy while extending.

Note

Attempt to evaluate your threat as soon as possible (type of aircraft). The utilization of break and hard turns against certain low wing loaded aircraft may allow him to close to gun range if the proper separation is not achieved first.

(C) IR missile defense capability is dependent on several specific factors:

a. Keeping sight of the bogey to realize a missile has been fired. (Obviously, the enemy thinks he is in, or near, his firing envelope.)

b. Maintaining sufficient airspeed to provide G capability which can produce maximum line-of-sight rate of change. It is this LOS rate which defeats the IR missile by either exceeding the tracking rate of its seeker head or causing its autopilot to command a course correction which exceeds the seeker head gimbal limits. Also, with sufficient airspeed, the throttles can be retarded to idle and the nose pointed down in the missile break turn; thereby, decreasing the heat source on which the IR missile is guiding.

c. There is nothing "magic" about holding the bogey just outside the published ATOLL capability cone. If you are unloaded in full afterburner (as you are in the extension) the missile MAY HACK IT - AND YOU!

Note

Threat aircraft may carry advanced IR-radar missiles with a capability far superior to the ATOLL; refer to section V, part 1 of the Secret Supplement.

(U) GUN THREAT

(C) Once a bogey has penetrated to a guns tracking position, escape is extremely difficult at best. The weak link in all present day airborne guns systems is the gyro pipper gunsight. As the target, you must optimize your maneuvering to take advantage of this weak link. The gunsight is only capable of solving elevation (lead) along a predictable azimuth path. Therefore, the target is providing the azimuth solution by its steady state flight path and allowing the tracking bogey to pull lead to solve the elevation problem.

Note

The expected enemy threat aircraft can outturn the F-4 at the medium-to-slow airspeed regimes and can pull lead at will. A 5G change in target G will change gun lead by approximately 100 mils.

(C) The obvious requirement to break the guns tracking solution is to vary your flight path to dissolve the azimuth track at such an interval that the bogey cannot reposition and pull his required lead. The required interval between flight path changes is approximately 4-6 seconds with the bogey at mid-range for guns (800-1200 feet) and something less as range decreases. The ultimate objective is negating the guns threat. To this end, you must strive to get out of effective guns range (maximum against a maneuvering target-3500 feet). Lighting afterburner and unloading would certainly do the trick, except for the IR missile threat. Therefore, other techniques must be developed. Certain maneuvers are optimized to produce continual azimuth change and lateral separation between flight paths, which can be

(C)
converted to angular separation and escape/extension at the proper opportunity. These maneuvers and the techniques for each are discussed in the following paragraphs.

Note

Full afterburner and pulling on the pole (especially 180° roll reversals) won't hack it!

(U) MANEUVER APPLICATION

(C) Following is a list of last ditch maneuvers and their application.

a. Break turn - Guns and missiles
b. Radical changes in flight path and airspeed - Guns.
c. Defensive roll away - Guns (low wing loaded, slow roll rate, guns only aircraft).
d. High-G barrel roll over the top - Guns.
e. High-G barrel roll underneath - Guns and missiles.
f. Defensive spiral - Guns (high wing loaded aircraft or rapid overshoot).
g. Maximum negative G-maximum positive G - Guns.
h. Split-S - Guns and missiles.
i. Idle, speed brakes, and maximum pull down into the shooter - Guns.

(C) In the break turn, 20-21 units angle of attack is applied to increase angle off and destroy the gun tracking solution and IR missile envelope. The maneuver bleeds energy excessively when the turn is sustained. The use of maximum rudder further destroys gun tracking.

(C) The high-G barrel roll is a high energy loss maneuver designed to rapidly reduce the forward velocity vector and force a bogey to overshoot from a close-in gun tracking position. As such, it is definitely classified as a last ditch maneuver. Caution must be exercised when executing the maneuver. The bogey must be no farther than 1500 feet in range. Maneuvering at maximum performance is critical since the resultant may place the F-4 in an even more disadvantageous position than originally; i.e., out of airspeed and ideas. The decision to execute the maneuver over the top or underneath is based on the F-4's airspeed: 350 KCAS or more is sufficient to execute a roll over the top. Anything less requires the roll underneath. The effect of gravity aids in completing the maneuver underneath.

Note

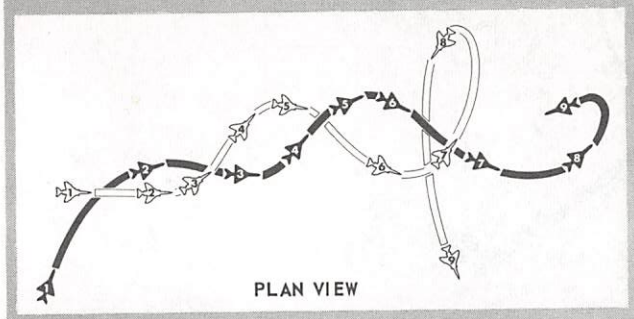
High-G barrel rolls must be practiced often to increase confidence and effectiveness. The time to learn how to perform them is not when you see tracers going by the canopy.

(C) The maximum negative G-maximum positive G maneuver is utilized to destroy gun tracking. The stick must be pushed forward until 2-3 negative G are acquired; hold for 4-5 seconds to allow the bogey to reverse. Positive G is then applied to obtain maximum angle off. The pilot should then unload, extend, and maintain angle-off until out of firing range.

(C) The split-S is used against guns or missiles, usually when the F-4 is at low performance and the pilot wants to obtain minimum turn radius or attempts to take the bogey into the weeds. A low wing loaded aircraft may be able to maintain a position inside the F-4 turn radius. Utilization of aileron and rudder during the maneuver aids in destroying gun tracking.

(C) Remember, the last ditch maneuver selected depends entirely upon the tactical situation. Initiate a break turn and quickly evaluate the angle off, overtake, type of aircraft and armament, if possible, and react.

ROLLING SCISSORS



Note

It is difficult for the bogey to retain visual contact in the Rolling Scissors. Be alert for an error in the bogey's actions that could result in a shot opportunity.

The Rolling Scissors is a last ditch maneuver to an estension/escape against a guns–equipped enemy. The need for, and the entry opportunity to, the Rolling Scissors may be generated by either: an overshoot by an enemy during a gun pass on you, or an overshoot by the F–4 (and subsequent bogey reversal) caused by pressing the bogey too closely. In simplest of terms, it is a series of barrel rolls around the enemy's flight path until sufficient angular separation is achieved to allow a disengagement. The efficient use of the F–4's ability to add/sustain energy and operate in the vertical is required to attain proper results. The constant change in azimuth during the maneuver makes it particularly suited to defense against a gun threat. (Refer to Last Ditch Maneuvering against guns, previously discussed.)

The Rolling Scissors can be commenced in any plane from any situation in which an overshoot has occurred. The entry is started by the F–4 rolling 90° to the plane of turn in which the overshoot has occurred (1) and commencing a 16 – 20 unit pull to create angular separation. If airspeed is above 350 KCAS at the overshoot continue to pull and roll into the bogey toward the vertical (2).

Note

If speed decays below 350 KCAS while forcing the initial overshoot, the Rolling Scissors should be initiated by a barrel roll underneath. The resultant Rolling Scissors has sometimes been called a Defensive Spiral.

The initial nose attitude attained is the key to the success of the maneuver. You are matching your nose attitude against your performance (ability to sustain that attitude). If the nose is not high enough residual performance will force you out in front of the bogey and you lose. If the nose is too high you will be unable to sustain the attitude, the nose will fall through, and you lose. Your objective is to sustain the highest possible nose attitude to force the bogey to come up to you. The F–4's excess thrust will allow you to sustain a higher attitude than your opponent. Don't pull back down into the bogey. Continue the roll across the top to keep the bogey in sight. If sufficient angular separation has been obtained, an opportunity to disengage by pulling toward the bogey's 6–o'clock exists while the bogey is nose high (3). Extend in the Lufberry and keep the bogey in sight (4). More than one roll may be necessary to achieve the disengagement opportunity.

FDB–1T–(26)

CONFIDENTIAL

Figure 1-16 (C)

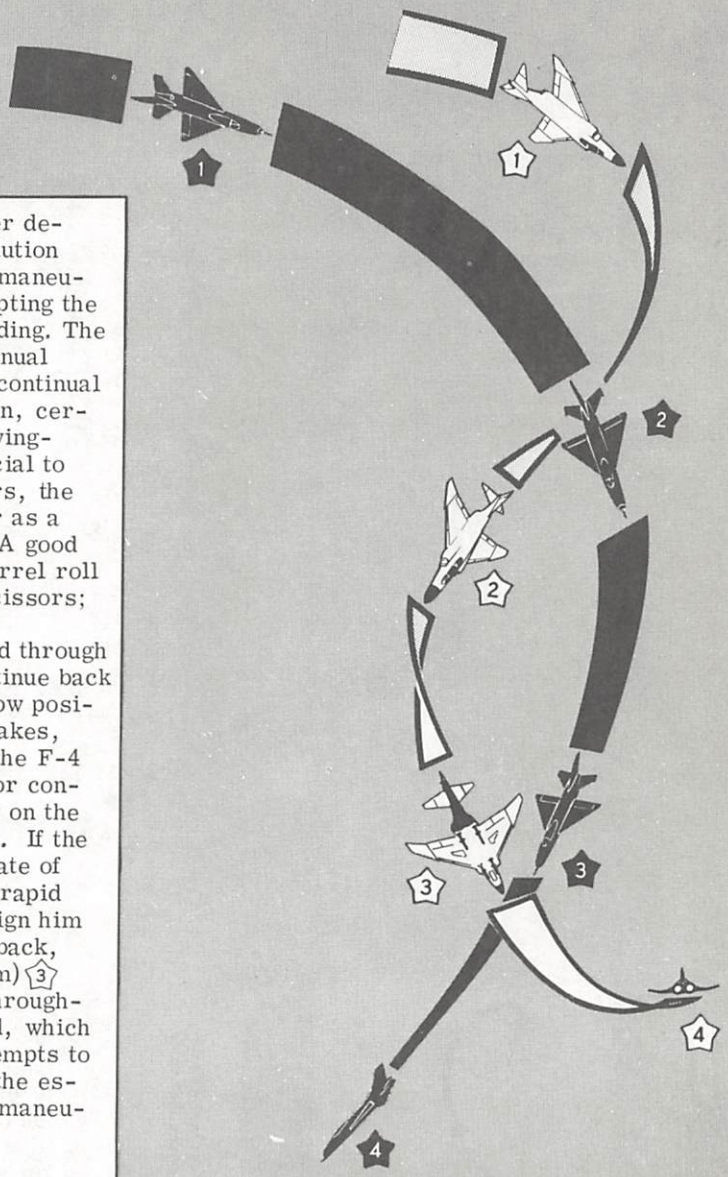
DEFENSIVE SPIRAL

The defensive spiral is a last ditch maneuver designed to break a bogey's lethal tracking solution and provide an opportunity for a separation maneuver. Caution must be exercised when attempting the maneuver against aircraft with low wing loading. The major attribute of this maneuver is its continual heading (azimuth) change under G, giving a continual erroneous gyro gunsight solution. In addition, certain aerodynamic principles unique to high wing-loaded/high frontal drag aircraft are beneficial to the maneuver. As in all defensive maneuvers, the F-4 must ease or "sneak" into the maneuver as a follow-on to a previous maneuver (series). A good entry opportunity comes out of the high G barrel roll over the top or underneath, or the rolling scissors; all last ditch maneuvers in themselves.

The technique is: As your nose is pulled through the horizon, retard throttles to idle and continue back pressure to force the nose to a steep nose-low position (1). The combination of idle, speed brakes, and a very high angle of attack will prevent the F-4 from accelerating. Throughout this, start (or continue) a roll (2) to attempt to align the bogey on the imaginary 12-to-6 o'clock line on the canopy. If the bogey is fairly close, he will tend to relax rate of roll and overshoot to the outside, wherein a rapid control reversal will roll your aircraft to align him on the 12-to-6 o'clock line. If he is further back, you will be able to roll into him (and with him) (3) to achieve the 12-to-6 o'clock alignment. Throughout this, lateral separation will be generated, which can be converted to angular as the bogey attempts to pull towards you, giving the opportunity for the escape from guns and subsequent IR extension maneuver (4).

Note

If the bogey does not attempt to follow the F-4 nose low maneuver, separate as soon as sufficient angular separation is attained.

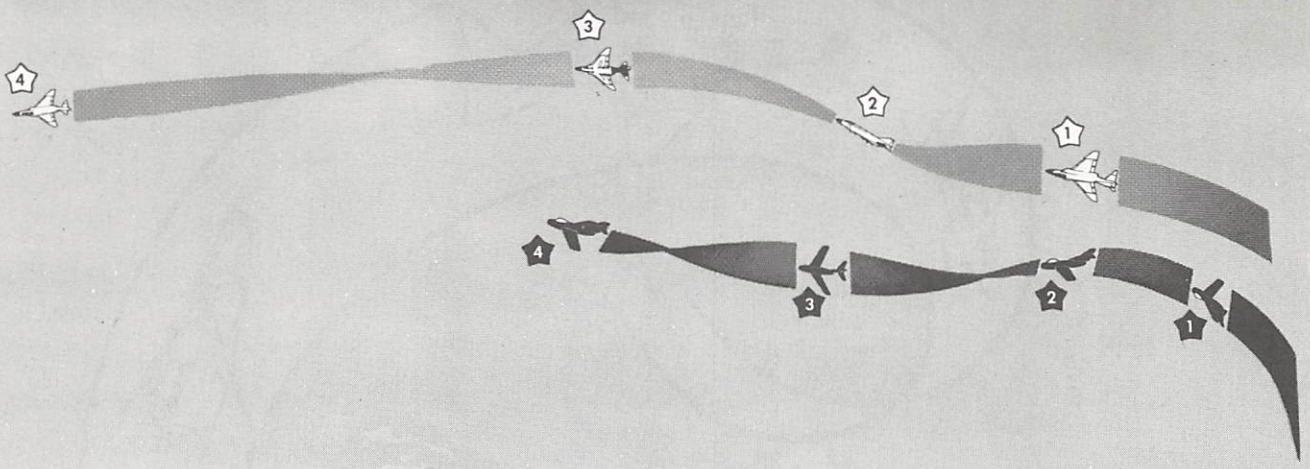


FDB-1T-(27)

CONFIDENTIAL

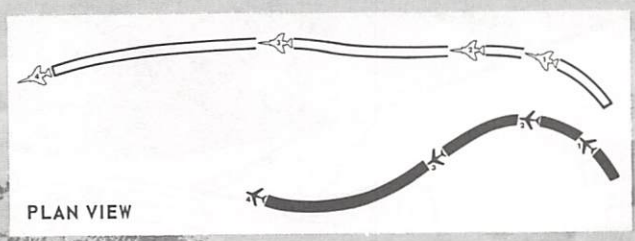
Figure 1-17 (C)

DEFENSIVE ROLL-AWAY



WARNING

THIS MANEUVER IS ONLY TO BE UTILIZED AGAINST GUNS ONLY AIRCRAFT.

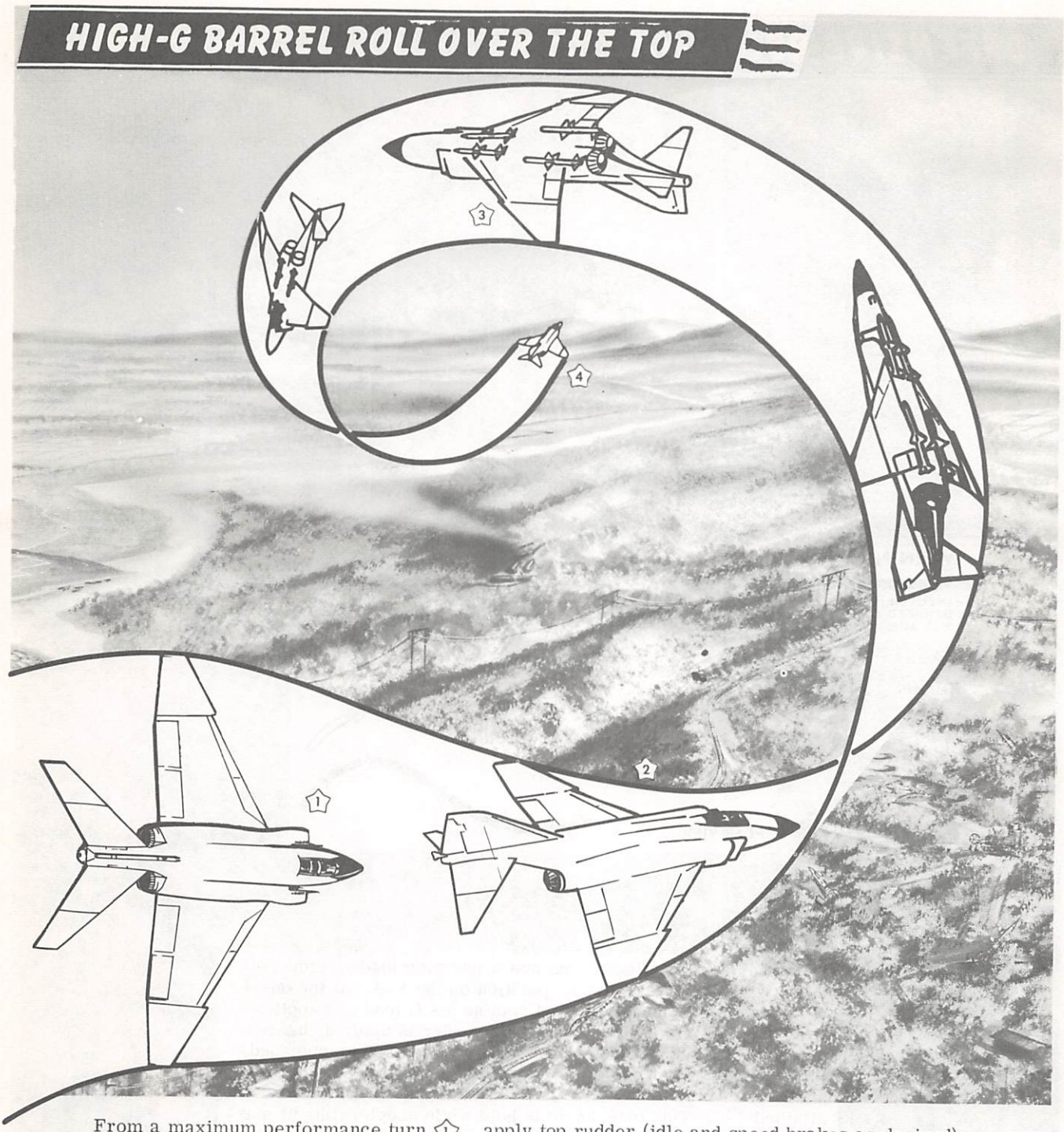


This maneuver is effective against a low wing loaded, slow roll rate aircraft that is in a guns position on the F-4. At the onset of the escape maneuver the F-4 retains his G load and applies hard top rudder (1). As soon as top rudder is applied, but not before, G load is reduced to, or near, zero G and an unloaded full aileron roll over the top, augmented by rudder, is initiated and held until the same bank angle in the opposite direction is attained (2). This bank angle is held while accelerating at maximum power and zero G for 5-7 seconds (3). During this time the bogey will not be visible. After the 5-7 seconds of unloaded acceleration a roll reversal back into the bogey should be initiated, along with a low (2-3) G turn (4). When the bogey is visually sighted G can be reduced to the point where visual contact is maintained, while simultaneously accelerating away for sufficient separation to pitch back into the fight and meet the bogey head-on.

CONFIDENTIAL

FDB-1T-(28)

Figure 1-18 (C)



From a maximum performance turn (1), apply top rudder (idle and speed brakes as desired) initiating a rolling reversal while maintaining maximum controllable angle of attack to change the forward velocity vector (2). Do not apply any aileron for roll. Throughout the maneuver airspeed bleed off will occur, decreasing G available. Back pressure must be adjusted to maintain the desired angle of attack (3). Strive to keep the bogey in sight throughout the maneuver in the event an opportunity to separate arises. At completion of the maneuver (4), maintain a nose-high attitude with optimum angle of attack to force an overshoot by the bogey and maximize his angle-off for a separation maneuver. It is not unusual to lose 200-300 KCAS during the maneuver if commenced from a high airspeed (400 KCAS or more).

CONFIDENTIAL

FDB-1T-(29)

Figure 1-19 (C)

HIGH-G BARREL ROLL UNDERNEATH

If less than 350 KCAS, the high G barrel roll maneuver should be accomplished by rolling underneath rather than over the top. The maneuver is commenced from a maximum performance turn (1) by applying bottom rudder (idle and speed brakes as desired) to initiate a nose down rolling reversal, while maintaining maximum controllable angle of attack (2). Do not apply any aileron for roll. Back pressure must be adjusted during the maneuver to maintain the desired angle of attack (3). Strive to keep the bogey in sight throughout the maneuver in the event the opportunity to separate arises. At completion of the maneuver (4) maintain back pressure at optimum angle of attack in a nose-high attitude to force an overshoot by the bogey and to maximize angle-off for a separation maneuver.

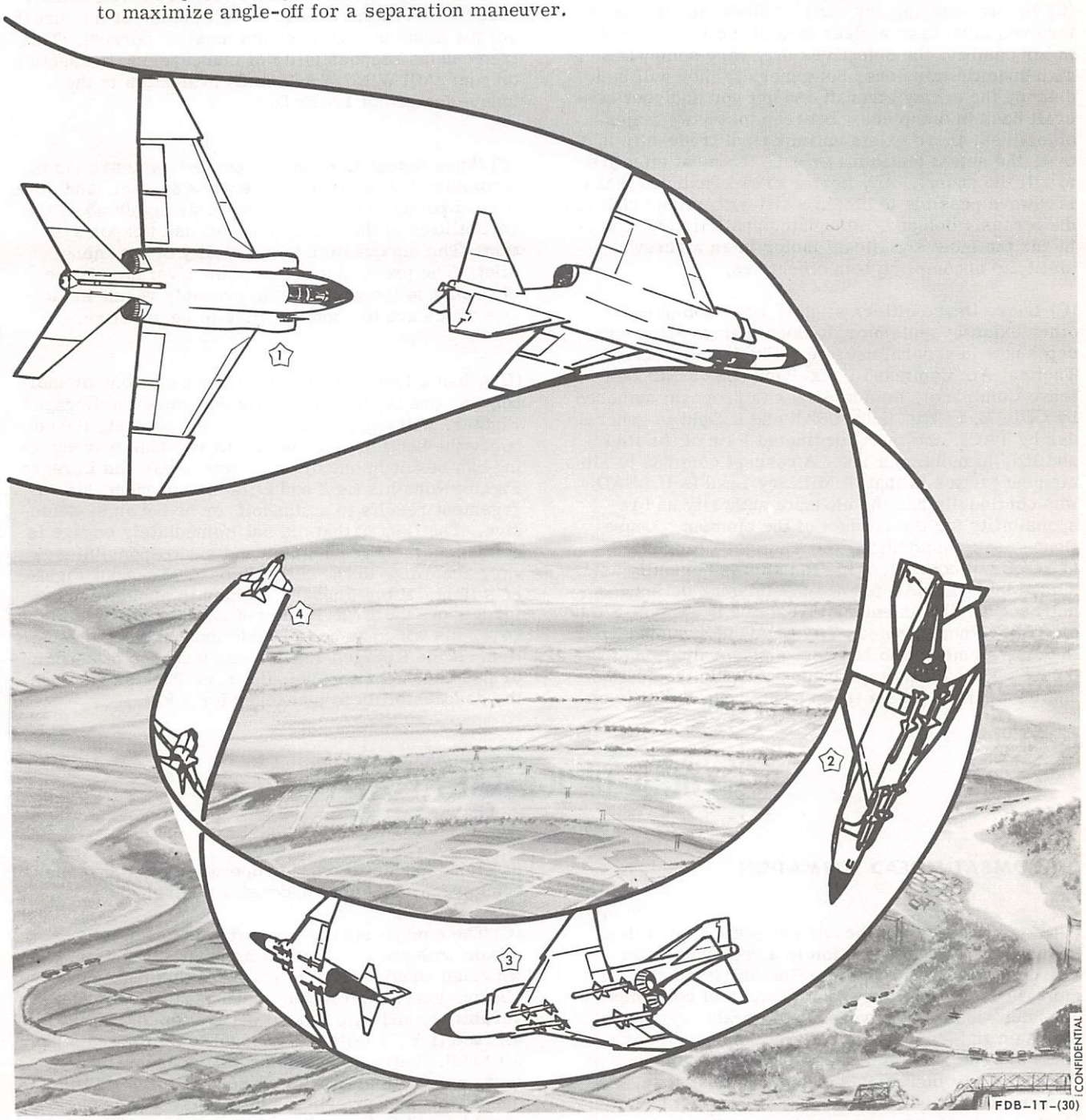


Figure 1-20 (C)

[redacted]

LOOSE DEUCE CONCEPT

(C) Loose Deuce is a general term describing a flexible two-aircraft team working in mutual support of one another in a tactical situation. It encompasses the defensive Combat Spread formation, several VID formations and the relationship of any two aircraft supporting one another during an air-to-air engagement.

(C) Before entering any tactical situation, the crews involved must have a clear idea of their objectives. In air combat, the objectives may vary somewhat with specific missions, but generally they will be to destroy the enemy aircraft and get you and your aircraft back in one piece. Between these two major objectives, there exists an important trade-off, in that, the safest tactic may not be the most effective to kill the enemy. Any fighter crew convinced that it is always possible to obtain a kill without any risk is dangerously deluded. Adequate, realistic training is by far the most significant factor in an aircrews ability to accomplish both objectives.

(C) Loose Deuce differs slightly when compared to other existing section or division maneuvering concepts now in general use; i.e., Fluid Four (USAF Tactical Air Command), Six-Pack (USAF Air Defense Command), Double Attack (a proposal authored by COL. E. E. Riccioni, USAF and not yet in general use by TAC), and the Coordinated Pair of the RAF and RN, to mention a few. A concept common to all element tactics is that of Military Lead (MILLEAD) who continually has the ultimate authority and responsibility for the conduct of the element. Loose Deuce uses, in addition, the Tactical Lead (TACLEAD) concept. This function is normally assumed by MILLEAD for normal mission duties, or until engaged by an enemy threat, be it bogeys, SAM, or AAA. When engaged, TACLEAD is assumed by the crewmember who has best sight/evaluation of the threat. This ability to maneuver/deploy the section and its weapons puts a tremendous responsibility on the Military Wingman (MILWING), forcing him to be fully capable of operating not only his fighter offensively and defensively but also to make important tactical decisions. He must be prepared to intercept, engage, and destroy any enemy. This level of competance can only be achieved by an intensive, realistic, and continuing ACM training program which includes flying against aircraft which closely simulate expected threat aircraft. His evaluation of the threat versus mission requirements must be correct. This tremendous responsibility of maneuvering the section on your (MILWING/TACLEAD) evaluation is the unique feature of Loose Deuce.

(C) When facing an enemy in combat, you are facing a combination of aircraft, weapons system, and pilot. It is important to know all that is available about the capabilities of the enemy aircraft and weapon system. The big question is the ability of the enemy pilot. The presumption that your adversary is the best pilot in the world would probably result in tactics which are too conservative to be effective.

(C) When a Loose Deuce Section engages one or more bogeys, one fighter, which we designate the Engaged Fighter, will engage, in one-on-one combat, the one bogey the section plans to kill first. This maneuvering can result in one of three outcomes: the Engaged Fighter wins his fight and kills his opponent; his engagement results in a standoff, or he becomes defensive. The fighter that did not immediately engage is defined as the Free Fighter and his responsibilities vary according to the outcome of the Engaged Fighter's fight. If the Engaged Fighter is maneuvering for a shot, the Free Fighter's responsibility is to cover his wingman and provide lookout for the section. If the Engaged Fighter has fought to a standoff or has become defensive, the Free Fighter also has the responsibility to maneuver for a kill.

NEW

LOOSE DEUCE TACTICS

(U) COMBAT SPREAD FORMATION

(C) Combat spread is the normal section patrolling formation. This information is a compromise of search capability, formation flexibility and control, mutual cover, weapons system, and fuel consumption considerations. With weapons of greater capability, the basic fighter unit has become the two-aircraft section. The section possesses adequate amounts of the necessary ingredients of lookout capability, maneuverability, and effective use of weapons carried. Most important, however, is the fact that the section is harder to split in an engagement. The section is easily adaptable to carrier operations (e.g., rendezvous, recovery, etc.) and radar control.

(C) The combat spread formation is essentially abeam with about 1-2 miles aircraft separation. The wingman should strive to maintain this position abeam, varying elevation as necessary for maneuverability, and with lateral separation determined by altitude (i.e., 1 mile at sea level to 2 miles at high altitude). Lateral separation will decrease below these values in areas of reduced visibility or if frequent hard maneuvering is necessary. The wingman should avoid flying in the exact same horizontal plane as lead to reduce the probability of visual detection.

[redacted]

(U) Lookout From Combat Spread

(C) The basic requirement for mutual support is good lookout doctrine. To properly protect the 6 o'clock area of a combat spread formation, each aircraft performs continuous in-place maneuvers consisting of variations in altitude, course changes of at least 10°-15°, and wing dips. In addition, the formation must perform frequent, random turns to aid in clearing the rear hemisphere. With a 1-mile spread, the section blind zone is approximately 1 mile aft. Most air-to-air missiles can be launched from that distance with great effectiveness. Assuming a speed of 400 KCAS, an attacker approaching from 6 o'clock at 550 KCAS reaches gun range (3500 feet) from the blind zone in 11 seconds. Even the F-4 cruising at 400 KCAS cannot prevent a 1-mile 550 KCAS attacker from reaching gun firing range. To minimize this danger, cruise as fast as feasible (450 KCAS is the recommended minimum) and clear your 6 o'clock. The combat spread formation provides acceptable protection only when flown with disciplined lookout doctrine. An effective lookout doctrine must consider the sun, cloud cover, contrails, background, smoke trails, burner puffs, and the direction of the expected threat. Effective lookout coverage also requires systematic visual scan (figure 1-21) and a coordinated search pattern. Pilot and RIO field of view is shown in figure 1-22.

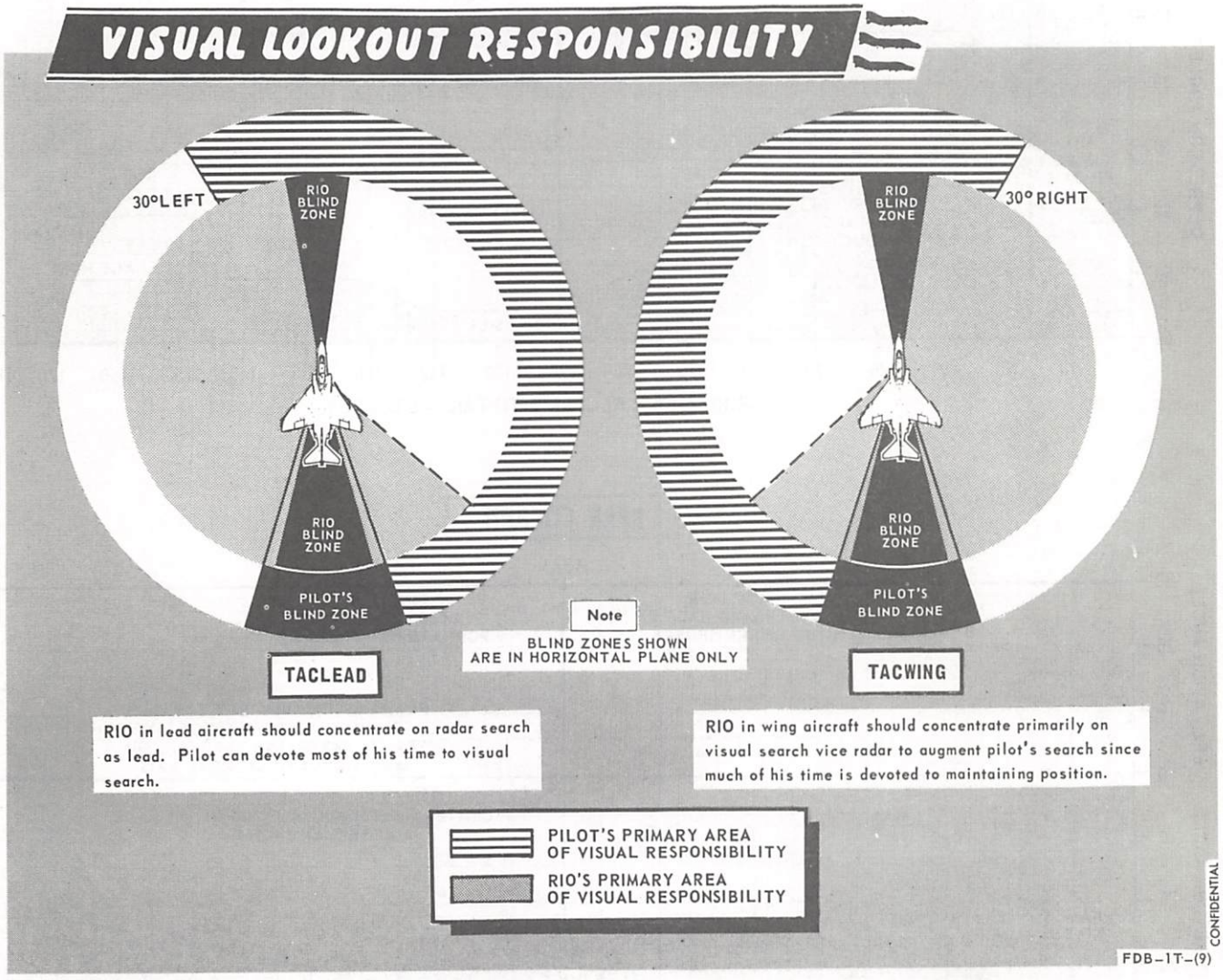
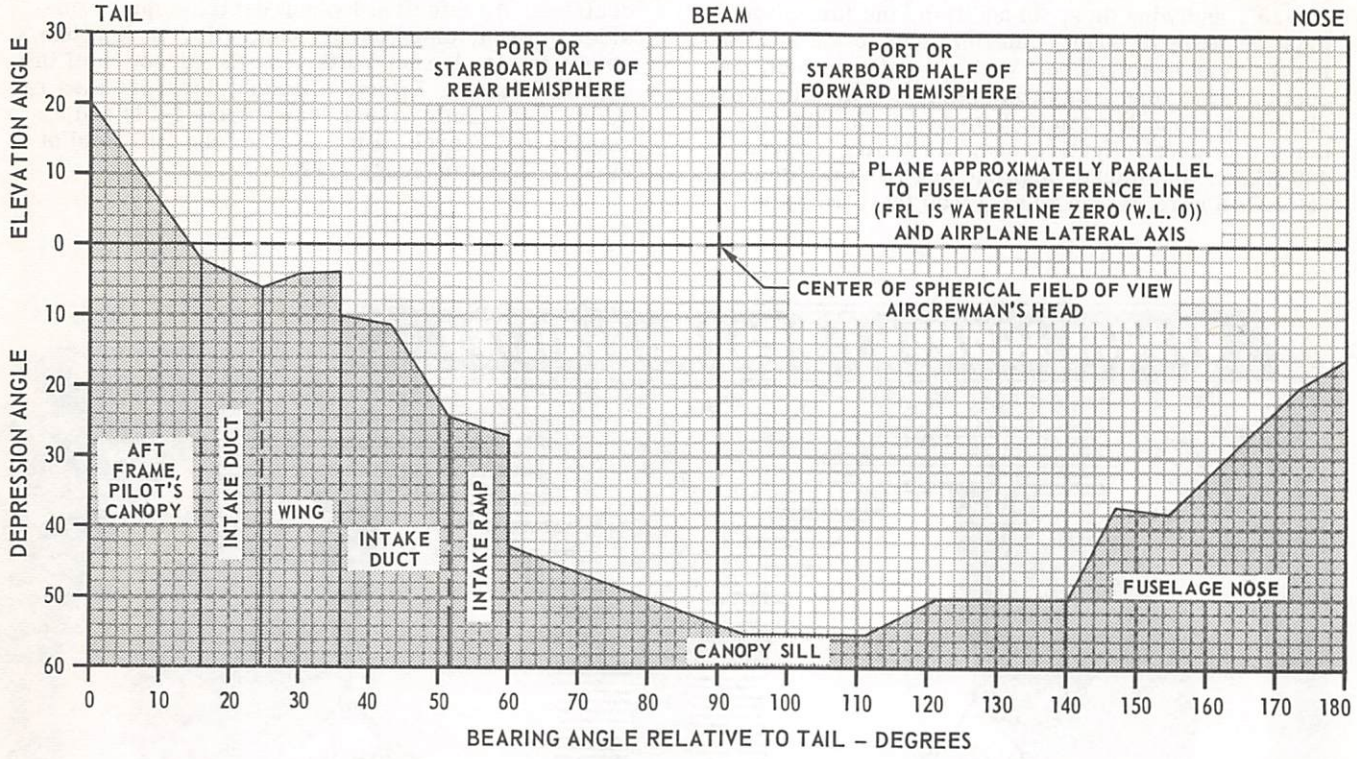


Figure 1-21 (C)

FIELD OF VIEW

FRONT COCKPIT



REAR COCKPIT

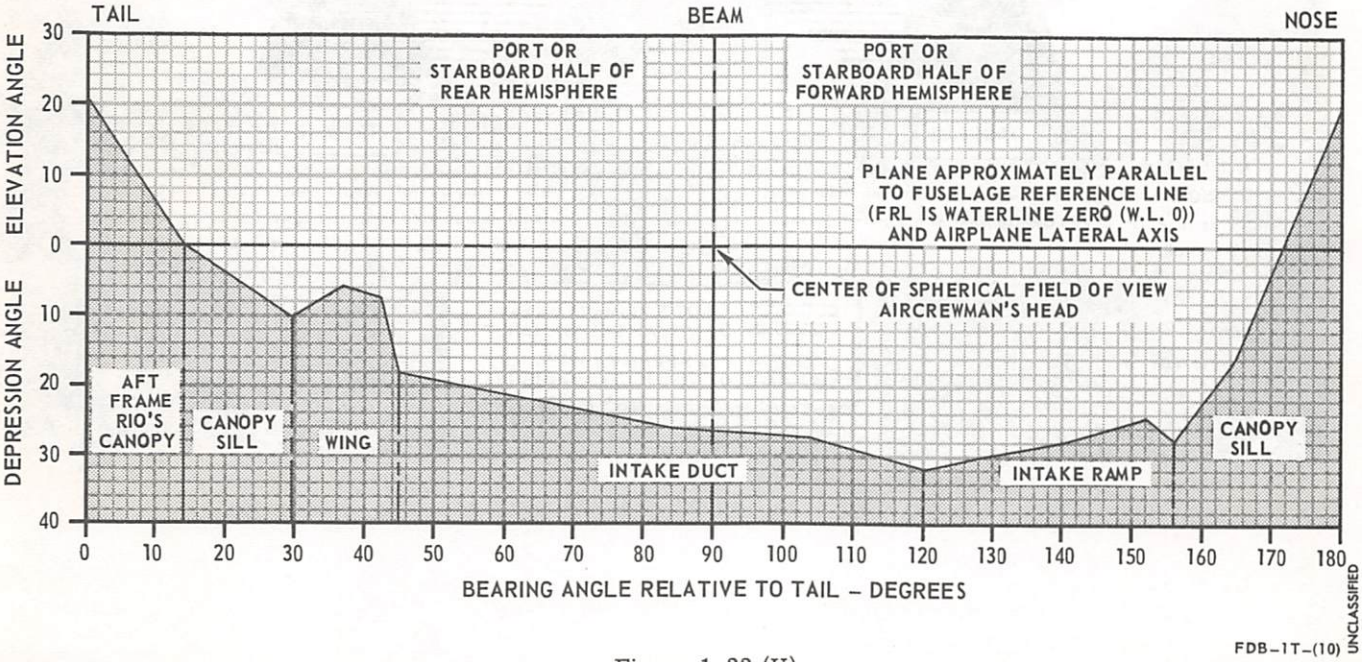


Figure 1-22 (U)

(U) Pilot Lookout Responsibility

(C) The pilot's visual responsibility while patrolling is primarily towards the inside of the formation. If his position is on the right of the formation, he should search from 30° right of the nose counterclockwise to the visual limit aft, which is considered his area of Prime Visual Responsibility (figure 1-21). His visual search pattern should be in this sector about 75% of the time with the remaining 25% devoted to the outside of the formation. In a visual engagement, once the pilot gets an initial TALLYHO on a bogey, especially at extreme ranges, he must keep the bogey in sight (PADLOCK). The PADLOCK call essentially means: I am visually locked on the bogey and cannot afford to look away. The pilot calling PADLOCK is visually locked on the bogey and becomes TACLEAD. The wingman is then entirely responsible for offensive lookout.

(U) RIO Lookout Responsibility

(C) While patrolling, the RIO must have a systematic method of visual scan and radar search. The particular pattern of radar/visual search is left up to the individual or squadron doctrine; however, the maximum time in any one area should be limited to 15-20 seconds. The RIO's visual scan should include his entire visibility limits, but should concentrate primarily on his area of Prime Visual Responsibility. The RIO's Prime Visual Responsibility area is the entire side away from the formation and the area inside the formation which is aft of the pilot's visibility limit (figure 1-21). An alternate procedure for scan responsibility in the combat spread is for each pilot to scan 100% of the area and for the RIO's to alternate between the scope and a visual scan which concentrates on the 6 o'clock area. The visual scan areas are not all equally important. A bogey contact at 1 mile ahead is not as critical as a mile astern. Although the above techniques give guide lines for lookout responsibility, all crewmen must concentrate on the stern area; the area of greatest threat.

(U) RADAR TACTICS (PRE-ENGAGEMENT PATROLLING)

(C) The most important problem in the discussion of radar contacts is identification of the target in a non-GCI environment. The AN/APQ-72 and AN/APG-59 radars have a long range detection capability in the forward quarter which provides valuable information in sufficient time so that it may be used effectively. For squadrons operating with AN/AWG-10 systems, the combinations of search patterns available while on the pre-engagement patrolling phase are numerous. However, for maximum radar coverage of aircraft working in a section, the recommended modes are: Lead aircraft - pulse doppler, 100-mile scale; wingman - pulse, 25/50-mile scale. This method ensures that aircraft approaching the beam aspect will be detected more readily. The RIO searching in pulse doppler will have a greater probability of acquiring low flying targets than the RIO searching in pulse mode. The RIO searching in pulse will be capable of detecting bogeys approached from the beam and stern areas. When any target or targets are detected, a radar contact report should immediately be made prior to acquisition. After obtaining a lockon, the attack display should be examined to obtain as much information about the target as possible. To obtain an approximate target heading, turn to establish a collision course. Hold the target at zero drift and maintain the same azimuth on the scope. If the target is given an estimated speed, which for medium and high altitude will be very close to the F-4 normal speed or 500 KTAS, and if an approximate collision course is established, the bogey heading is approximately equal to the fighter heading plus 180° plus twice the angle off. Simply stated, to find the bogey heading, apply twice the angle off to the 6 o'clock position of the HSI/BDHI on the side opposite the bogey. An additional method of determining bogey heading can be obtained in the following manner. If the target is on the left side of the scope, his heading will fall on the right side of the HSI, and vice-versa. To break it down further, check the V_C gap. Figure 1-23 illustrates target heading as a function of V_C for co-speed collision course. For a simple usable method to obtain a rough target heading, figure 1-23 also illustrates how the HSI may be broken into eight equal sectors corresponding to scope position (right or left) and V_C. If V_C is less than 900 knots, the X_3 position may be used to obtain an expanded display. In heat mode steering, straight and level attitude, the aim dot will provide a good indication of small altitude differences between the target and you. For large altitude differences, the elevation strobe or delta H on the ADI may be used. From the initial contact and lockon, the following information should be gained:

a. Possible number of targets, and type of formation.
b. Direction to turn for collision course.
c. A rough target heading.
d. Approximate target altitude (delta H on ADI).

(C) The flight leader should define the flight radar and search responsibilities thoroughly before takeoff. It is recommended that both aircraft radars search from the ground (or as low as possible) to the highest expected threat altitude. Both aircraft are generally searching the same volume of space; however, detection probability is increased. One-bar scan is recommended (and used by most RIO's); however, the three-bar scan may be used effectively.

(U) AN/AWG-10 RADAR AND LOOKOUT

(C) The added flexibility of the F-4J AN/AWG-10 radar in the automatic acquisition pulse doppler mode can free one of the two RIO's to spend most of his time in visual search. Thus, in a hostile environment the combat spread could put three crewmen on almost full time visual search. The other RIO should spend about equal time scanning the radar (pulse and/or PD) and searching visually.

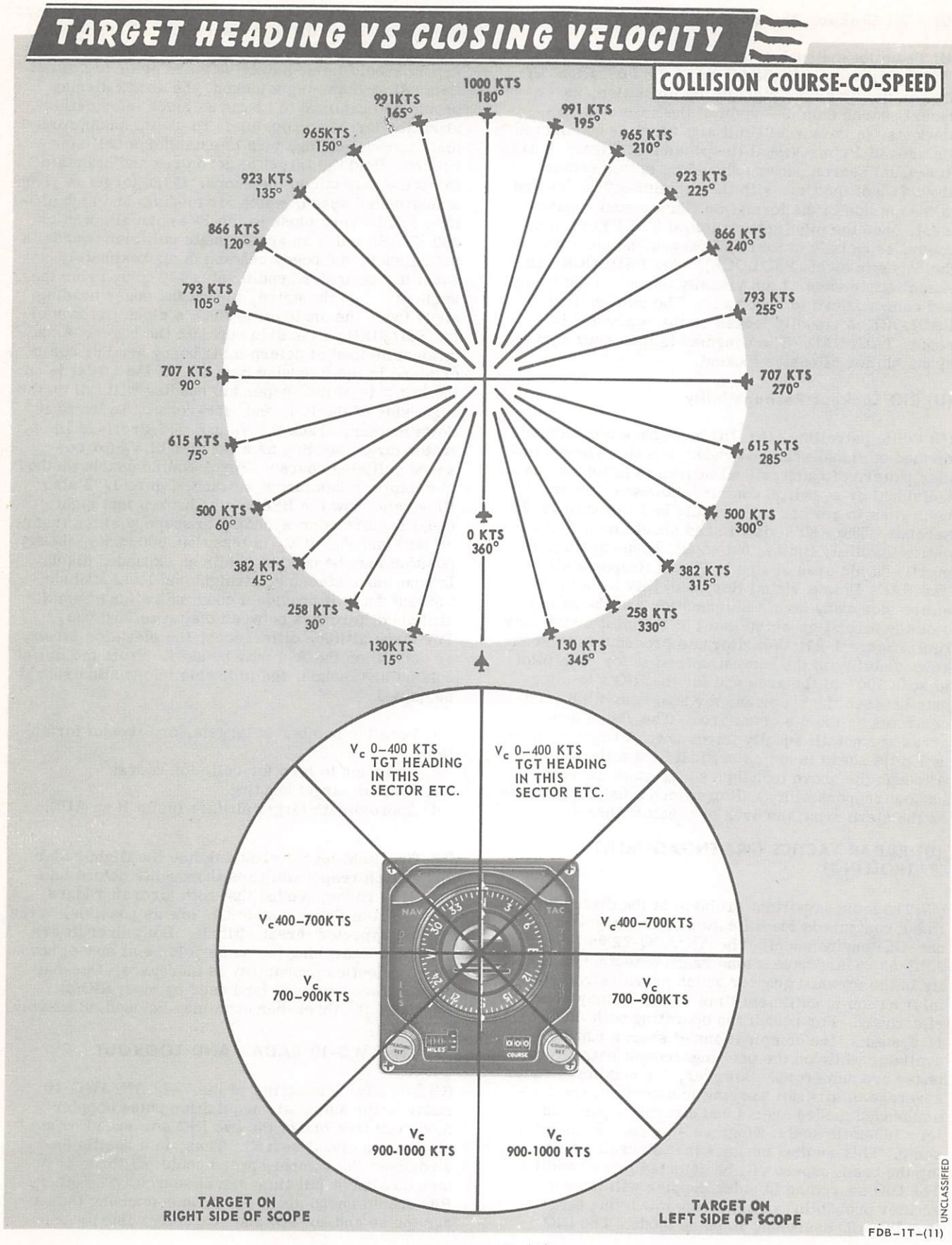


Figure 1-23 (U)

This page is UNCLASSIFIED

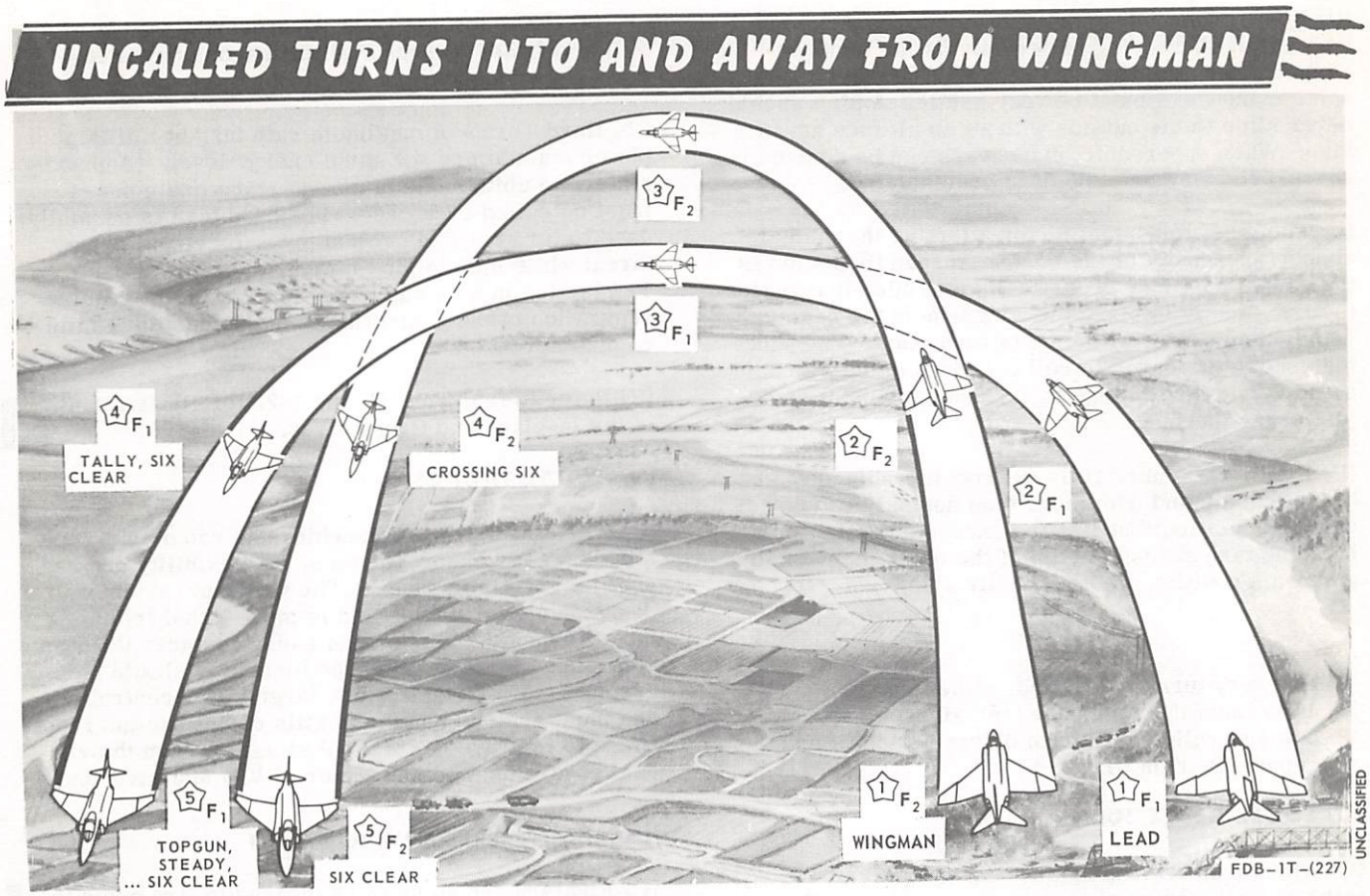


Figure 1-24 (U)

(U) COMBAT SPREAD CRUISING

(U) Called Turns

(U) Called turns are used primarily in formation training and lack the flexibility necessary in combat. They will not be discussed here but are similar to uncalled turns predicted in the following paragraphs.

(U) Uncalled Turns

(U) Uncalled turns demand that the wingman maneuver immediately in such a manner that he can adjust to the correct tactical position whenever the leader rolls out. All turns are done in yo-yo fashion by the wingman, mildly for gentle turns and steeper for harder turns. The wingman always maneuvers relative to the leader during cruise, and assumes the position of an equal partner during loose deuce maneuvering.

(U) An uncalled turn into the wingman is a much more pronounced yo-yo type turn than the relatively flat called turn. The wingman executes a high yo-yo so as to pass approximately 2000 feet ahead of the leader with a significant altitude advantage (figure 1-24). As the leader goes out of sight under the fuselage, the wingman increases his angle of bank without increasing G to visually reacquire the leader on the insde of the turn on parallel headings. As the leader continues the turn, the wingman drifts down and aft. As the wingman approaches abeam, he will increase his angle of bank, lower his nose slightly to accelerate while low yo-yoing to the inside of the turn, passing well below and just aft of the leader. The low yo-yo is continued to the inside abeam position. The wingman continues this cycle without reference to a roll out heading, but always in a position to reassume the combat spread position from any point in the cycle in minimum time, while maintaining an optimum scan pattern for mutual protection. The leader should hold a turn away for at least 60°.

(U) Uncalled turns away from the wingman are initiated by "over-banking" the leader to cut rapidly to the inside of the turn. As he passes the leader's 6 o'clock position at approximately 3000-4000 feet aft, he reduces angle of bank to match the leader's angle of bank and continues the low yo-yo to the inside. If the turn is continued as he approaches the abeam position, maneuvering is continued as in the uncalled turn into the wingman.

Note

The yo-yo type maneuvering employed in uncalled turns allows the wingman to move rapidly out to the combat spread position as the leader levels his wings.

(U) Yo-yo maneuvers during cruise turns should be very mild, increasing in severity as the turns become tighter. At altitudes above 40,000 feet, subsonic maneuvers must be very gentle. A pilot should never slide to the outside without an altitude advantage. When supersonic, maneuvers can be done more sharply but they must be done precisely.

(U) The most important factor affecting the mutual support capability of the combat spread formation is the abeam position. If tactically feasible, it is better to turn slightly to place the wingman on the beam rather than cruise while out of formation. The wingman should endeavor to roll out of all turns with some vertical advantage to exchange for position adjustment if needed.

(U) If either member rolls out considerably ahead of his teammate and with more than normal altitude advantage, he should utilize the excess potential for a clearing turn across the top of the other member to an abeam position on the opposite side.

Note

As every turn is executed, either into or away from the wingman, both aircrews should automatically check each others 6 o'clock and report clear on UHF.

(U) LOOSE DEUCE TURNS

(C) When maneuvering against enemy aircraft the following categories of turns are normally used:

Break turn
Hard turn

a. Break turn - An instantaneous, maximum performance turn (approximately 20 units angle of attack) designed to destroy the tracking solution of gun armed fighter or air-to-air/surface-to-air missile. The BREAK call should be modified by direction to turn (left/right) and when possible by GUNS, ATOLL, or SAMS. This last term is informative only. It tells your teammate what armament is being brought to bear. The break turn call will normally be followed immediately by an afterburner call.

(1) BREAK LEFT GUNS. A maximum G turn in full CRT when the attacker is within the gun envelope (tracking inside 3000 feet). In this case, the radio call indicates that the attacker is within the lethal gun cone at 7 o'clock.
(2) BREAK LEFT ATOLL. A maximum G turn in military power. This radio call should be made if an attacker is seen to fire an air-to-air IR missile. Delay afterburner selection or terminate afterburner until the missile is defeated.

Note

The ATOLL break is the only break turn made without afterburner and is intended for use against heat seeking missiles.

(3) BREAK SAMS. A nose-low hard turn into the missile is executed in CRT.
(4) Refer to Last Ditch Maneuvering in the Fighter Versus Fighter discussion for further maneuvers.

b. Hard Turn - A maximum rate turn at military power maintaining the same energy level. (Approximately 16 units angle of attack). Maximum power must be called if desired. The hard turn is normally used to turn the F-4 section toward a visual enemy threat while maintaining maximum energy. Basic F-4 tactics in a defensive or offensive fight require separation between aircraft of more than the 1 mile combat spread.

(U) Refer to figures 1-25 and 1-26 for illustrations of the In-place and Cross turns.

(U) RADAR TACTICS

(C) When the F-4 section achieves a radar intercept attack against enemy fighters, its flexibility and capability greatly increase. The weapons system was designed for intercepts and is more lethal in this mode. When the section has radar contact without clearance to fire, a VID type formation should be assumed. These tactics are largely RIO controlled and must achieve maximum kills during the intercept phase to improve the tactical situation when the visual engagement begins (refer to VID Maneuvering).

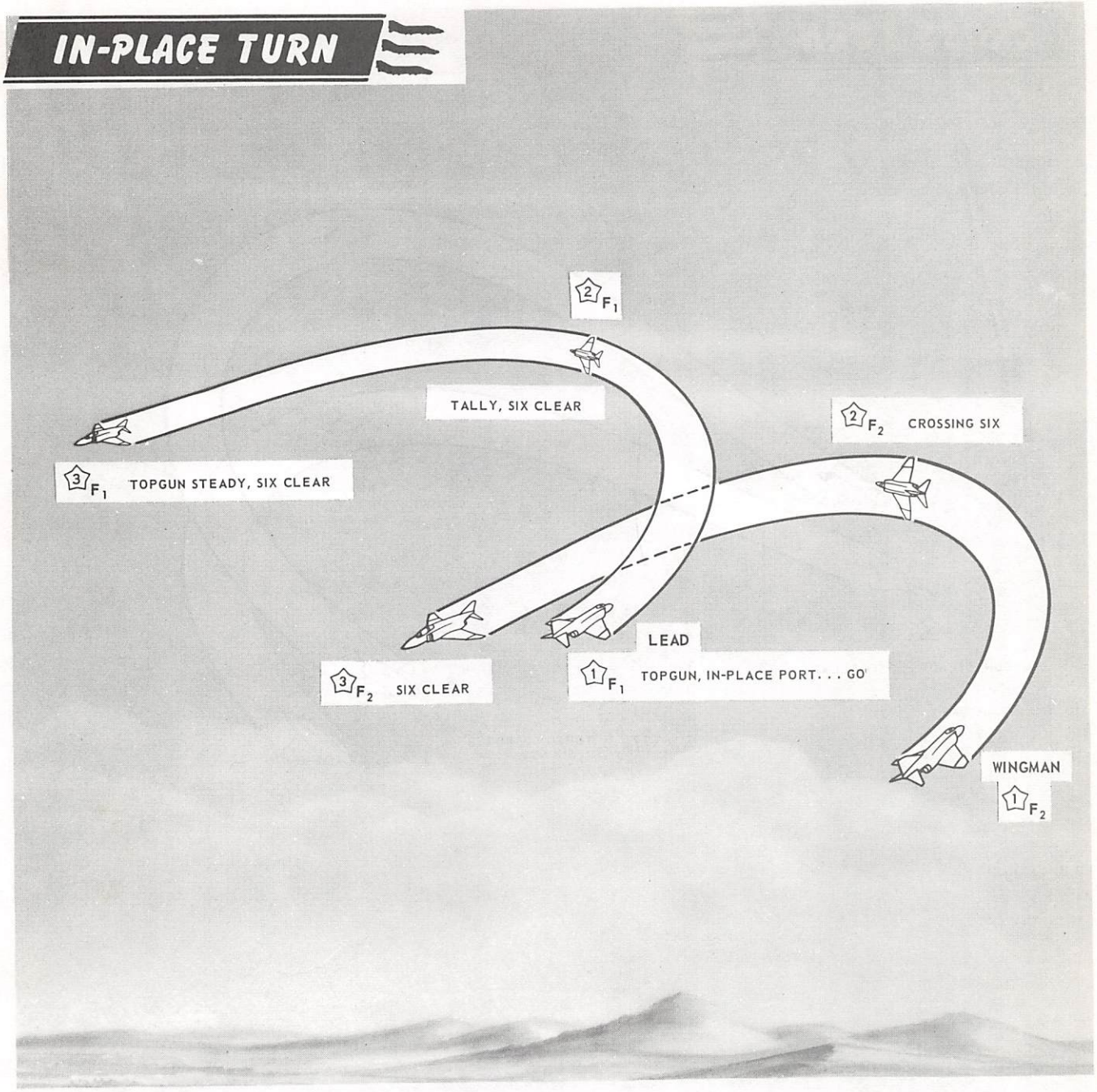
(U) MISSILES-FREE ENVIRONMENT

(C) Fighters are sometimes cleared to fire prior to visual target identification. The F-4 weapons system (no dogfight computer installed) is designed for this environment, but the fire control solutions are only accurate predictions of the AIM-7 capabilities for head-on non-maneuvering targets. Refer to AIM-7 Capabilities and Limitations in part 3 of this section. The number of missiles fired is dependent upon the tactical situation and the number of missiles being carried; however, firing two or more missiles increases the kill probability. The missile firing timing has tactical implications which must be considered.

a. Firing at maximum "in range" (10 to 13.5 nautical miles) allows firing at the first opportunity, a possible long range kill, and may decrease enemy penetration. However, if the enemy observes the smoke or receives GCI warning of the missile launch, he may attempt an escape maneuver. If the enemy initiates a 2G turn, his maneuver defeats the missile capabilities and, if he continues his turn, a long range tail chase may result.

b. Firing at maximum ASE circle expansion (0.6 R_a - 6 to 8 nautical miles) may deny the enemy escape capability; however, a defensive maneuver in excess of 3G will defeat the missile.

c. If missile firing is delayed until 0.4 R_a (shrinking ASE circle at one-half maximum diameter - 3 to 5 nautical miles), the enemy cannot defeat the missile capabilities except possibly by a continuous last ditch maneuver. Firing after 0.4 R_a approaches or is inside minimum range. Ranges previously stated vary with altitude, airspeed, and target maneuver as depicted in figure 1-67.



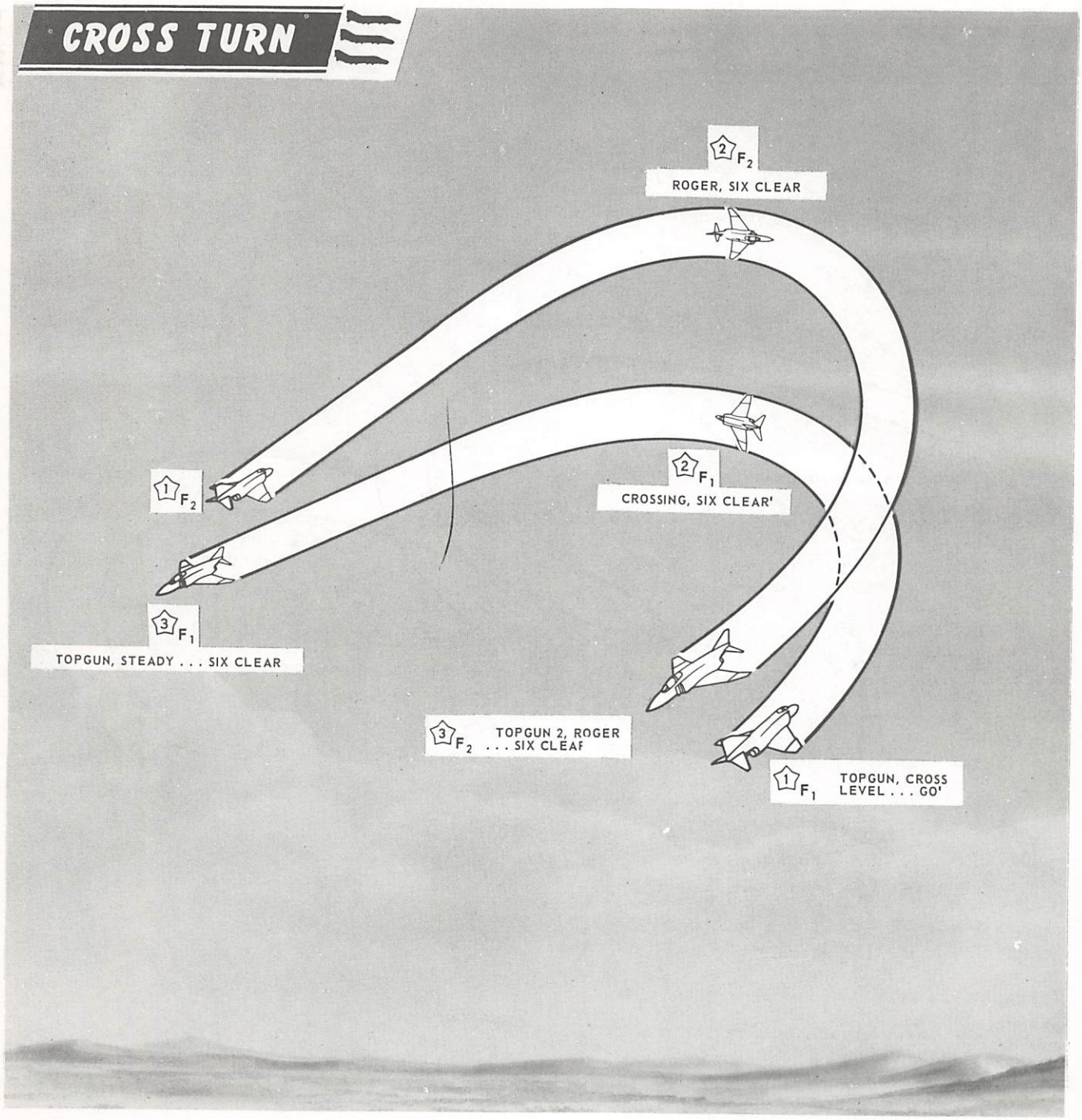
In-place turns are used to engage or counter attacks from the outside of the standard combat spread formation. This type of turn may be utilized at any range to counter a threat from the forward quarter and at longer ranges (2 miles minimum) to meet rear quarter attacks head-on. In-place turns are not used to engage a bogey inside of the formation, particularly at the respective 5 and 7 o'clock positions of the Loose Deuce aircraft (refer to Cross Turn).

In-place turns are generally military or maximum power hard turns performed level, low, or high and rarely exceed 180° of turn. UHF response by the wingman to the leader's initial command is mandatory, particularly in an in-place turn away from the wingman where the leader loses sight through the initial portion of the turn. Noncompulsory CROSSING SIX and SIX CLEAR calls are advisable as an aid in maintaining mutual support. The maneuver is terminated on the call of STEADY.

UNCLASSIFIED

FDB-1T-(226)

Figure 1-25 (U)



Cross turns are used to engage or counter a threat from within or between the section. Classically it is utilized to bracket a bogey passing head-on between the combat spread formation. The cross turn may also be used to engage a stern threat between the section at sufficient range (2 miles minimum) to meet the bogey head-on.

Cross turns are generally military or maximum power hard turns performed level, low, or high (vertical reverse) depending on the section's airspeed and relative elevation of the threat. Particular care should be taken in passing abeam one another with lateral separation to maintain visual mutual support. SIX CLEAR calls at this point are advisable as an aid in maintaining mutual support. The call STEADY terminates the maneuver.

UNCLASSIFIED

FDB-1T-(225)

Figure 1-26 (U)

(U) RADAR SIGHTINGS REPORT

(U) Radar contact UHF transmissions -

CALL SIGN	TOPGUN ONE CONTACT
MAGNETIC BEARING	270
RANGE	35 MILES
ELEVATION	3 ABOVE
IMMEDIATE RESPONSE	TOPGUN TWO NO JOY
CALL SIGN	TOPGUN ONE ROGER
MAGNETIC BEARING	275
RANGE	32 MILES
ELEVATION	3 ABOVE
V_C	900 KNOTS
INSTRUCTIONS	I HAVE THE EYEBALL, STARBOARD HARD

(U) Multiple Bogeys

(U) For unidentified multiple radar contacts, the following terminology is used:

a. FAR BOGEY - Bogey at greatest range on scope.
b. NEAR BOGEY - Bogey at closest range on the scope.
c. With two or more bogeys, they are designated numerically with close range bogey always number one, etc.
d. With two or more bogeys equidistant in range on the scope, they are designated as LEFT, CENTER, or RIGHT.

(U) VID MANEUVERING

(C) The objectives of all VID maneuvering is to expeditiously close the bogey to visually acquire him in a manner which will maximize your capability to successfully defeat him. To achieve this objective, there are many types of VID maneuvers, four of which are shown in figures 1-27 thru 1-30. The decision as to which VID to employ must be based on many factors including weather, weapons system status, armament, rules of engagement, bogey information, sun position, enemy ground defenses, etc. Advantages and disadvantages of each VID maneuver are presented in a succeeding paragraph.

(C) TACLEAD (generally the first aircraft with radar contact) should determine the type of VID to be executed and maneuver the section accordingly. During the VID it is imperative that TACLEAD be quickly established through a positive UHF transmission; hesitation or indecision will negate completion of a successful VID. In order to assist TACWING in obtaining a lockon and to keep him abreast of the VID, all descriptive and directive commentary by TACLEAD should be made over the UHF (magnetic bearing, range, and elevation of bogeys). Radar information on bogey formation is paramount. Inside 10 miles it is generally preferable to give bogey's position off the nose vice magnetic bearing. Use of afterburner to eliminate smoke trails and increase energy depends primarily on visibility and existing fuel package.

(C) The lead RIO should quickly assess the existing geometry to determine the choice of eyeball aircraft and vector to alter aspect as appropriate. This can be best accomplished by going to collision bearing. An alternate method is to center the B-sweep and then check the aim dot. A dot on the right side of the scope, for example, would indicate that the starboard aircraft should "Go Eyeball" for a head-on ID or that a port displacement turn will increase existing aspect for a stern conversion. Since the aim dot and the B-sweep do not have the same scale factor, ambiguity may exist if the B-sweep is not centered prior to examination of aim dot position.

(C) TACWING should strive for a position abeam of TACLEAD during the initial portion of the VID/vector for bogeys. This allows the section to retain maximum flexibility in order to meet any change in the tactical situation (bogey jink, lead change, etc.). Separation between F-4's is flexible and many factors such as visibility, airspeed, and area threat influence it. However, TACWING must maintain positive visual contact with TACLEAD. As the terminal phase of the VID approaches, TACWING may consider sliding aft of the abeam position. Gaining nose-to-tail separation on TACLEAD provides some important benefits:

a. Increased visual support from the wingman. In most situations the wingman can look through the lead toward the threat area and can more effectively clear the lead's 6 o'clock, as well as visually acquire the bogeys.
b. Increased section effectiveness. Any bogey turning on the lead aircraft will sandwich himself and provide an early take-out by the wingman. Since all loose deuce tactics are based on the two-on-one concept, quick elimination of one or more opponents should be of utmost importance.
c. Increased time in envelope before R_{min}.
d. Higher TCA at firing in head-on VID.

Note

- In a forward quarter or head-on situation, moving TACWING aft of TACLEAD's beam in the terminal phase will degrade the mutual support lookout coverage of TACWING's 6 o'clock.

- Early visual sighting is optimized by having the pilot center the heat dot, allowing the RIO to give continuous descriptive commentary. This is most significant when only one aircraft has radar contact.

(C) Advantages and disadvantages of each VID maneuver are as follows:

a. VID to head-on attack -

Advantages:

(1) Minimum time to bogey identification.
(2) Minimum raid penetration.
(3) Difficult for bogey to visually acquire F-4's.
(4) Easier to detect bogey jink.

(C)

Disadvantages:

(1) Initially, only AIM-7 option.
(2) Identification does not occur in ACM launch zone.

b. VID to stern attack -

Advantages:

(1) Identification occurs in ACM launch zone.
(2) Initially, both AIM-7 and AIM-9 option.
(3) F-4's start with tactical advantage.

Disadvantages:

(1) Harder to detect bogey jink.
(2) Greater raid penetration.
(3) Easier for bogeys to visually acquire F-4's.

c. VID to vertical attack -

Advantages:

(1) VID in the ACM launch zone.
(2) Initially, both AIM-7 and AIM-9 option.
(3) F-4's start with a tactical advantage.
(4) Difficult for bogey to visually acquire F-4's.

Disadvantages:

(1) Requires high aircrew proficiency.

d. VID to vertical separation attack -

Advantages:

(1) Minimum time to identify bogeys.
(2) Minimum raid penetration.
(3) Shooter initially has AIM-7 or AIM-9 attack option.
(4) F-4's start with a tactical advantage.
(5) Difficult for bogeys to visually acquire both F-4's.
(6) VID occurs in the ACM envelope.

Disadvantages:

(1) Requires high degree of aircrew proficiency.
(2) Aircraft are placed at Q limits.
(3) External stores significantly limit effectiveness.

(U) VID To A Head-On Attack

(C) Upon initial radar contact, the section establishes a collision course and maneuvers to obtain an altitude differential if tactically desired. Generally TACLEAD will be the aircraft closest to the bogeys' flight path. The section remains in combat spread until approximately 20 miles; then TACWING maneuvers into the shooters position, aft of TACLEAD's beam with about 3 nautical miles separation. TACWING remains in search until 15-16 miles to detect other bogeys. Afterburner may be selected between 12 and 20 miles. At 8 miles TACLEAD breaks collision and selects HEAT; TACWING turns to center the radar dot. TACLEAD centers the heat dot when 4-6 miles from the bogey. This places the bogey in the optical sight if 35 mils is selected. Upon identification, TACLEAD clearly states: ABORT, ABORT, F-8's, A-4's, etc., or MIG's, MIG's, MIG's. The MIG's, MIG's, MIG's call is clearance for TACWING to fire. From this point loose deuce engaged tactics apply. On aircraft with VTAS, the helmet sight can be used to help visually locate the bogey. With radar lockon, the mode discrete light on the helmet sight illuminates when the helmet sight reticle is within 3° of the radar antenna look angle (VTAS/RADAR mode selected). This feature can be used to pinpoint bogey position.

(U) VID To A Stern Attack

(C) Upon initial radar contact the section establishes a collision course. TACWING remains in search to detect any other bogeys in the area. The conversion to a stern attack should commence between 18-20 miles depending on initial aspect. In order to minimize the possibility that the bogeys visually acquire the F-4's, it is important that the VID be accomplished with adequate lateral separation (at least 7 miles). This requires good aircrew coordination to hold the bogey near the edge of the scope during the beginning of the turn back to bogey heading. When V_C drops or at 5-7 miles, TACLEAD turns hard into the bogey to center the B-sweep and flies the heat dot. The F-4's should attempt to roll out about 2 to 3 miles behind the bogeys with a good speed advantage. TACWING flies a cover position. The same identification or abort calls as previously discussed are used. If the bogey turns toward the F-4's, which is evidenced by an increase in V_C, TACLEAD must call HEAD-ON, HEAD-ON.

(C) During the VID to a stern attack the requirement for an altitude differential (high, low, co-altitude) depends primarily on such things as sun position, visibility, and cloud cover. If an altitude differential is used the terminal phase will be executed in the oblique plane. The requirement for lateral separation will be decreased in direct proportion to the altitude differential gained.

(U) VID To A Vertical Attack

(C) This maneuver is started from a head-on set up and is a stern VID executed in the vertical or oblique plane. Afterburner is selected at 12 to 20 miles and the fighters accelerate to at least 650 KCAS. At this high calibrated airspeed the fighters are relatively safe from stern attacks and therefore combat spread may be reduced to about 1000 feet of lateral separation. This greatly improves the fighter formation maneuverability. TACLEAD must establish 9000 feet of vertical separation between the fighters and the bogeys. The heat dot/elevation strobe can be used to determine this separation by using the formula: range x degrees x 100 equals altitude difference. The elevation strobe will be 9° at 10 miles, 18° at 5 miles, and 30° at 3 miles. At 3 miles, a 6G pull-up must be commenced at no less than 650 KCAS.

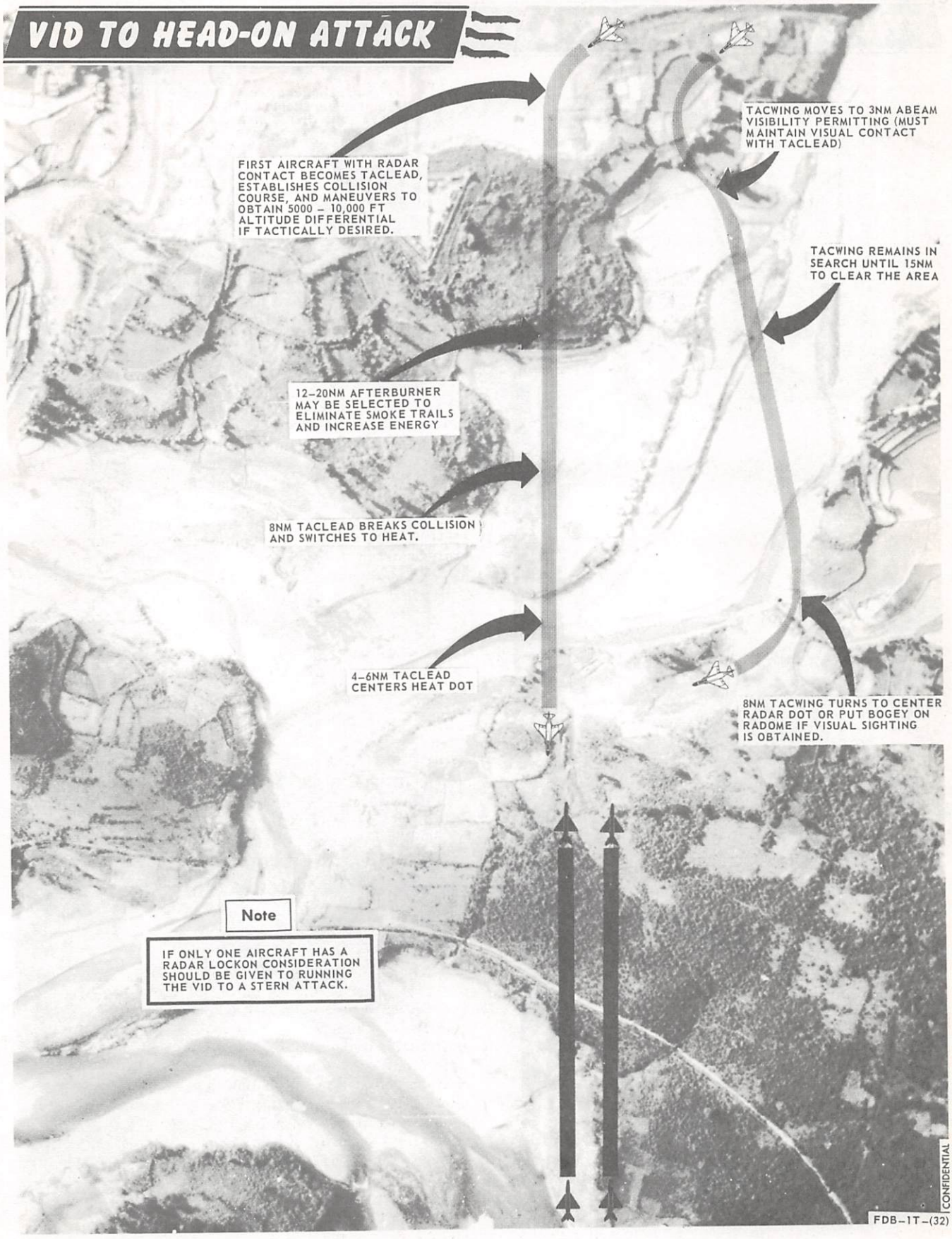

VID TO HEAD-ON ATTACK
FIRST AIRCRAFT WITH RADAR CONTACT BECOMES TACLEAD, ESTABLISHES COLLISION COURSE, AND MANEUVERS TO OBTAIN 5000 – 10,000 FT ALTITUDE DIFFERENTIAL IF TACTICALLY DESIRED.
TACWING MOVES TO 3NM ABEAM VISIBILITY PERMITTING (MUST MAINTAIN VISUAL CONTACT WITH TACLEAD)
TACWING REMAINS IN SEARCH UNTIL 15NM TO CLEAR THE AREA
12–20NM AFTERBURNER MAY BE SELECTED TO ELIMINATE SMOKE TRAILS AND INCREASE ENERGY
8NM TACLEAD BREAKS COLLISION AND SWITCHES TO HEAT.
4–6NM TACLEAD CENTERS HEAT DOT
8NM TACWING TURNS TO CENTER RADAR DOT OR PUT BOGEY ON RADOME IF VISUAL SIGHTING IS OBTAINED.
Note
IF ONLY ONE AIRCRAFT HAS A RADAR LOCKON CONSIDERATION SHOULD BE GIVEN TO RUNNING THE VID TO A STERN ATTACK.
CONFIDENTIAL
FDB–1T–(32)

Figure 1-27 (U)

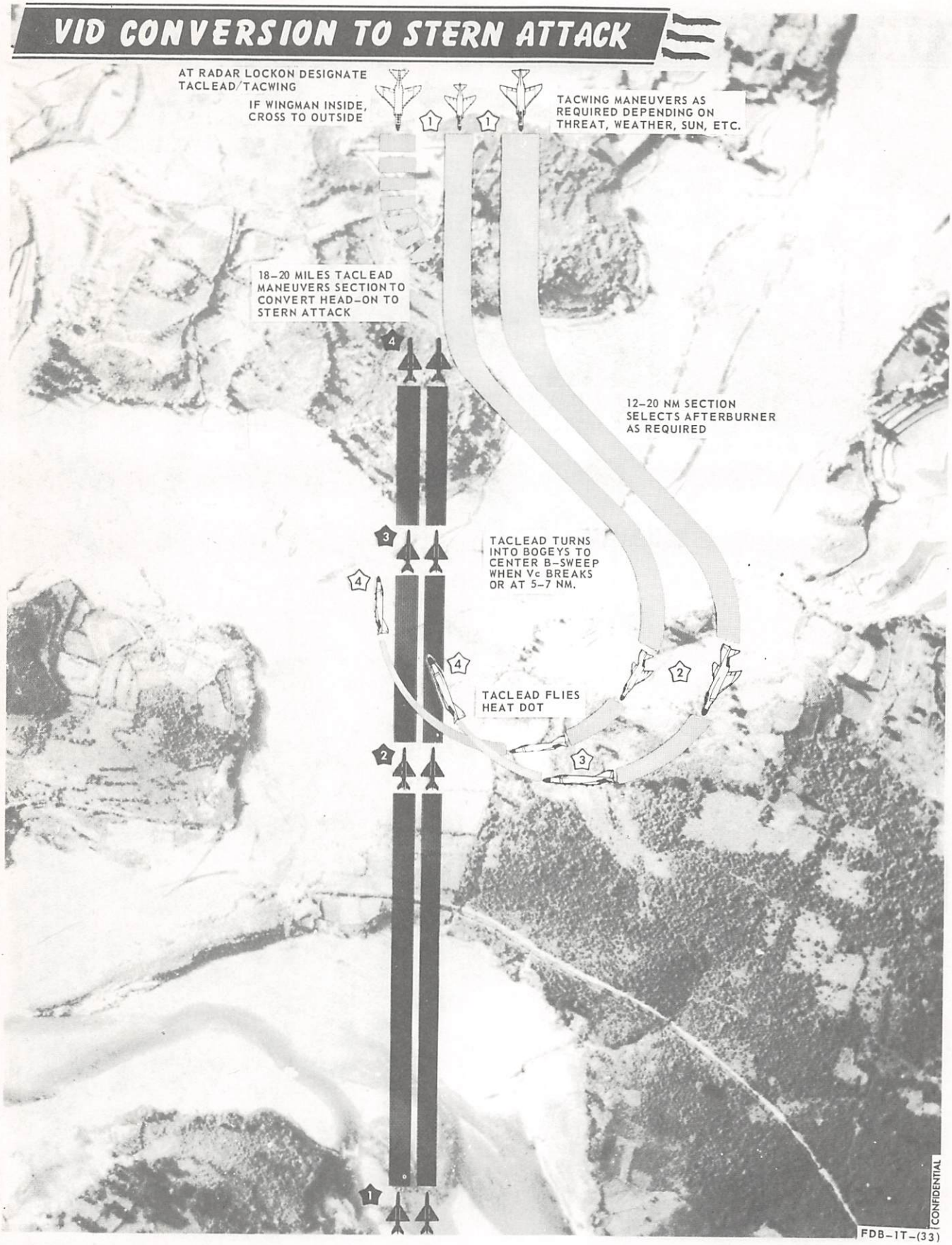

VID CONVERSION TO STERN ATTACK
AT RADAR LOCKON DESIGNATE TACLEAD/TACWING
IF WINGMAN INSIDE, CROSS TO OUTSIDE
TACWING MANEUVERS AS REQUIRED DEPENDING ON THREAT, WEATHER, SUN, ETC.
18–20 MILES TACLEAD MANEUVERS SECTION TO CONVERT HEAD–ON TO STERN ATTACK
12–20 NM SECTION SELECTS AFTERBURNER AS REQUIRED
TACLEAD TURNS INTO BOGEYS TO CENTER B–SWEEP WHEN Vc BREAKS OR AT 5–7 NM.
TACLEAD FLIES HEAT DOT
CONFIDENTIAL
FDB–1T–(33)

Figure 1-28 (C)

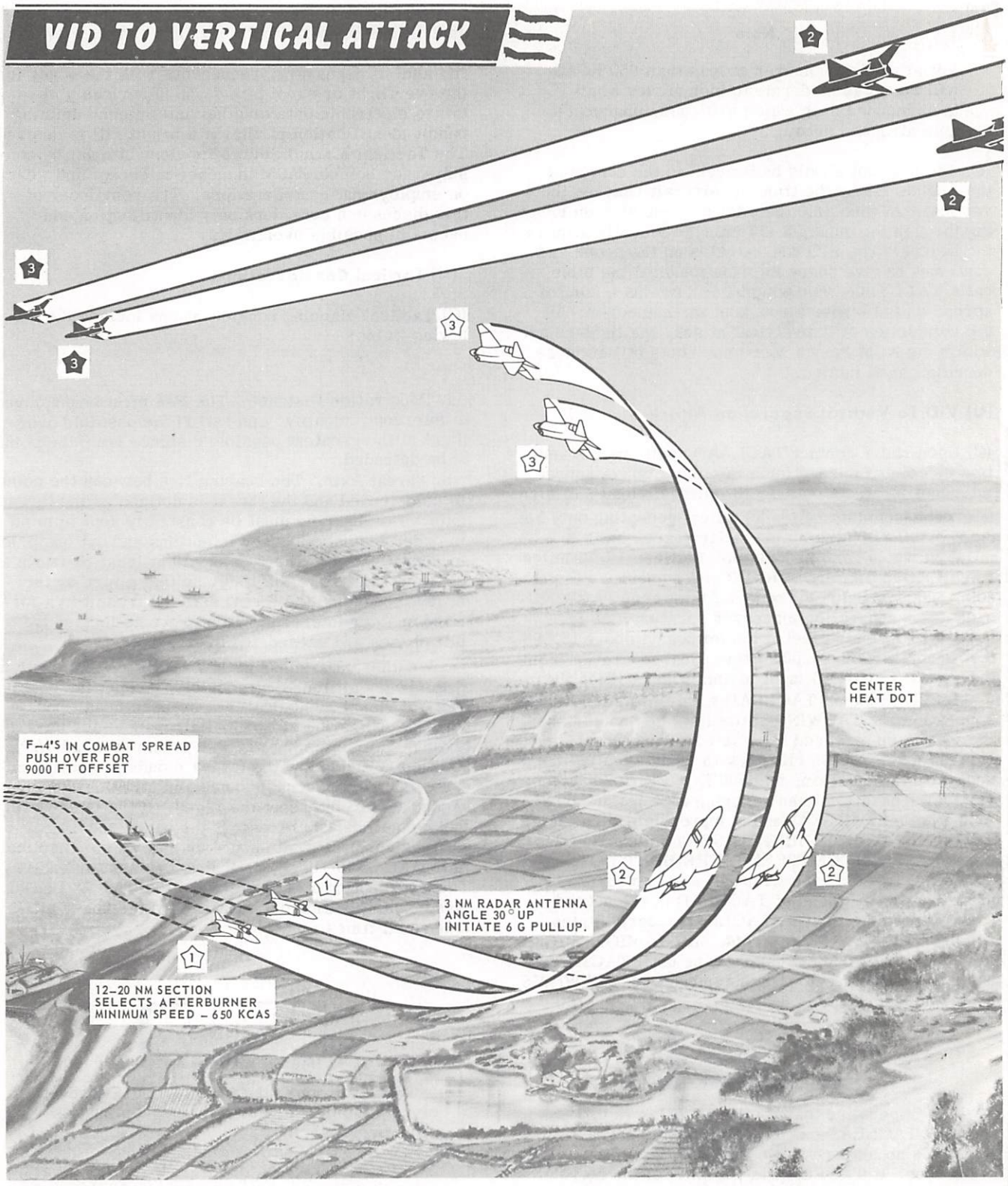

VID TO VERTICAL ATTACK
F-4'S IN COMBAT SPREAD
PUSH OVER FOR
9000 FT OFFSET
12-20 NM SECTION
SELECTS AFTERBURNER
MINIMUM SPEED - 650 KCAS
3 NM RADAR ANTENNA
ANGLE 30° UP
INITIATE 6 G PULLUP.
CENTER
HEAT DOT
PLAN VIEW
CONFIDENTIAL
FDB-1T-(34)

Figure 1-29 (C)

(C)

Note

Initiating the maneuver at less than 650 KCAS will result in moderate to high angles of attack/induced drag which will cause unacceptable airspeed decay.

(C) The heat dot should be brought to the center of the ASE circle by the time the aircraft reaches the vertical. At this time the pilot concentrates on looking through the gunsight (35 mils) to visually acquire the bogeys. The RIO concentrates on the scope and continues to give bogey information until the pilot calls TALLYHO. The wingman maintains a combat spread on the leader throughout the maneuver. At the completion of the vertical attack, the fighters are within the ACM launch zone and should utilize loose deuce engaged tactics.

(U) VID To Vertical Separation Attack

(C) Upon radar contact TACLEAD positions the section in combat spread for a minimum target aspect intercept (contacts outside 20 miles) or lead collision intercept (contacts inside 20 miles) accepting only hot drift. TACWING maintains radar search until 20 miles at which time he locks up. Between 15-20 miles TACLEAD calls MIN BURNER and maneuvers to get 3000-5000 feet below the bogey. At this time TACWING executes a separation maneuver splitting high for bogeys below 15, 000 feet or low for bogeys above 15, 000 feet to obtain 7000-10, 000 feet vertical separation from the bogey. TACWING must maintain his position abeam or slightly acute on TACLEAD with minimum lateral separation. If TACWING splits low, he should gain the maximum airspeed associated with external stores carried (i.e., 700-750 KCAS with 10, 000 feet vertical separation when clean, and 600 KCAS with 7000 feet vertical separation when carrying a centerline tank). At 5-8 miles TACLEAD calls appropriate range (e.g., 8 MILES) and SWITCHING TO HEAT followed at 3-5 miles by the call CENTERING THE HEAT DOT. TACWING levels at the first call and maneuvers to place his pipper ahead of TACLEAD at the second call. Upon identification TACLEAD clearly states ABORT, ABORT, F8's, A-4's, etc. or MIGS, MIGS, MIGS. TACWING must delay firing until TACLEAD has passed astern of the bogeys and is out of TACWINGS center windscreen.

WARNING

It is imperative that TACWING delay firing until TACLEAD passes astern of the bogey and is no longer visible in the front windscreen. If TACLEAD is within 7° of the target and has approximately the same closure rate, the AIM-7 may be unable to distinguish the correct target.

(U) NIGHT/ALL WEATHER VISUAL IDENTIFICATION/ RENDEZVOUS

(C) The primary consideration in tactical planning for point defense is minimization of the overflight penetration distance. The F-4 aircrew is expected to analyze the bogey azimuth bearing, range, elevation, speed, heading, and its options; then intercept, identify and, if necessary, rendezvous with the bogey for the overflight or shoot him down. Previously obtained electronic data or other intelligence defining bandit identification is vital if a bandit kill is desired. The Tactical Manual Secret Supplement must be consulted for bomber/ASM launcher intercept and weapon employment considerations. The remainder of this discussion considers only identification and escort of possible overflights.

(U) Tactical Considerations

(C) Tactical planning considerations include the following items:

a. Penetration Distance. The F-4 must be employed to intercept, identify, and escort the possible overflight at the greatest possible distance from the point to be defended.

b. Threat Axis. The bearing line between the point to be defended and the threat is defined as the threat axis. This bearing must be constantly kept in mind in order to analyze bogey intentions and options prior to identification. The F-4 should at least maintain a position relative to the bogey so that a turn by the bogey inbound on the threat axis will result in a forward quarter intercept. This prevents long range tail chases and unescorted overflights.

c. Weather. Darkness or low visibility/IFR weather at the bogey altitude degrades or prevents the possibility of visual identification. In these conditions, the best utilization of two F-4 aircraft is accomplished by maintaining one F-4 in an overhead CAP position (VFR) below the lowest clouds to prevent unescorted photo reconnaissance and utilizing the second F-4 to intercept the bogey. If the intercepting F-4 cannot identify or escort the bogey because of weather conditions, it should maintain a 1 to 2 nautical mile trail on the bogey until it is declared friendly. The intercepting F-4 should keep the CAP F-4 advised of its position and altitude and the bogey altitude at all times.

WARNING

In IFR conditions, the intercepting F-4 must closely monitor altitude when escorting possible overflights.

d. Multiple Targets. Recent experience indicates that two bogeys may fly in close proximity on overflight missions until 50 to 100 nautical miles from the target, at which time they may split and employ high-low tactics to prevent detection of the low aircraft. Multiple F-4 employment and radar search techniques should be optimized to counteract this tactic.

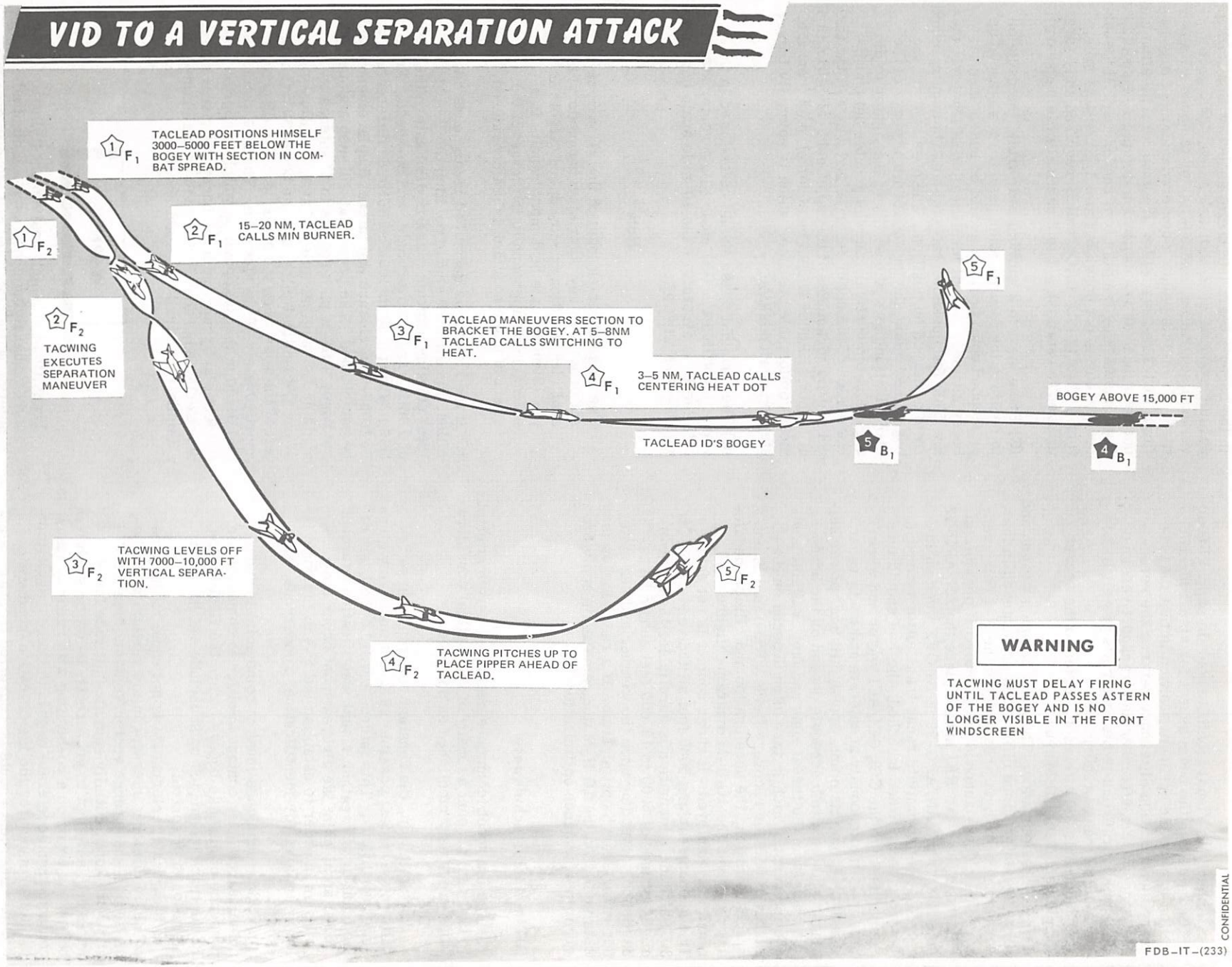

VID TO A VERTICAL SEPARATION ATTACK
1 F1 TACLEAD POSITIONS HIMSELF 3000–5000 FEET BELOW THE BOGEY WITH SECTION IN COMBAT SPREAD.
1 F2
2 F1 15–20 NM, TACLEAD CALLS MIN BURNER.
2 F2 TACWING EXECUTES SEPARATION MANEUVER
3 F1 TACLEAD MANEUVERS SECTION TO BRACKET THE BOGEY. AT 5–8NM TACLEAD CALLS SWITCHING TO HEAT.
4 F1 3–5 NM, TACLEAD CALLS CENTERING HEAT DOT
5 F1
BOGEY ABOVE 15,000 FT
TACLEAD ID'S BOGEY
5 B1
4 B1
3 F2 TACWING LEVELS OFF WITH 7000–10,000 FT VERTICAL SEPARATION.
5 F2
4 F2 TACWING PITCHES UP TO PLACE PIPPER AHEAD OF TACLEAD.
WARNING
TACWING MUST DELAY FIRING UNTIL TACLEAD PASSES ASTERN OF THE BOGEY AND IS NO LONGER VISIBLE IN THE FRONT WINDSCREEN
CONFIDENTIAL
FDB-IT-(233)

Figure 1-30 (C)

(C)

e. Aspect for Visual Identification. In night VFR or IFR conditions, the beam aspect for visual identification may be the optimum position in that the primary identification difference between the reconnaissance aircraft/bomber and transport versions of some aircraft lies in the long rows of well lit windows in the transport aircraft.

f. Electronic Identification. Refer to the secret supplement Tactical Manual.

g. F-4 Performance. The most common weapon and aircraft performance difficulties encountered in intercepting overflights result from the F-4 being vectored as a deck-launched interceptor. If possible in this condition, the RIO should place the AN/APQ-72 in STBY or the AN/APG-59 in B+ OFF when on internal power to initiate radar transmitter time-out before launch. When launched, the F-4 should turn immediately to the CCI/GCI/ACI vector and when steady, simultaneously accelerate and begin radar search. From this point, speed, altitude, power settings, and the climb schedule depend on the bogey distance from the threat zone and fuel available for the intercept, which in turn often depends on the status of deck or recovery fields. When fuel is not a consideration, the acceleration and climb schedules derived from the 1G H-M diagrams (figure 1-40) should be employed. If radar contact is not established upon reaching 5000 feet altitude and CCI/GCI/ACI altitude information is unreliable, then a level flight altitude of 5000 to 10, 000 feet should be established, depending upon the weather and sea state, for radar search optimization. If a radar lockon is obtained, then the 1G H-M diagrams again apply for climb/performance optimization.

(U) Intercept Techniques

(C) The intercept techniques described herein attempt to take into account as many of the tactical considerations previously mentioned as possible.

a. By definition, the constant collision course results in the fastest possible intercept under any given set of conditions. This intercept will be the basis of the night or all weather visual identification intercept.

b. At some point the aircrew must break the pure collision in order to establish the F-4 in the bogey's low beam area for identification, rendezvous, and escort.

c. Radar techniques must at some point include pulse search after contact in order to check for the presence of multiple bogeys before the final lockon. Radar track techniques must include emphasis on elevation drift control.

d. If aircraft performance is not equal to the pure collision climbing intercept in the vertical plane because of a short range vector/contact, then the F-4 aircrew should initially sacrifice altitude for performance. Attempt to get directly below or slightly behind the bogey on a co-heading with radar or visual contact, then accelerate to gain the necessary climbing performance for the identification/rendezvous.

e. The intercept should be converted from a constant pure collision at a sufficient range to place the F-4 in the bogey's beam (90° target aspect) with a lead pursuit solution at 2 nautical miles, 2000 feet vertical separation, and 50-100 knots speed advantage. From this point, a centered radar dot may be flown to 1/2 nautical mile. If visual identification has not been made at 1/2 nautical mile, the F-4 should be flown visually by the pilot to a rendezvous. If visual rendezvous is not possible from 1/2 nautical mile, then a THROTTLE BACK call is required and S turns utilized to establish a 1 to 2 nautical mile radar trail.

(C) From the 1 to 2 nautical mile trail, the decision to continue the identification pass from a stepped up or stepped down position should be based upon the bogey altitude. Visual identification of low level (below 5000 feet) unknown targets should be accomplished from a stepped up position. The possibility of the bogey descending during the terminal phase of the identification pass, the ability of the fighter to disengage in the vertical, and the greater natural illumination of the upper fuselage and wings of the target are the advantages of this approach. Identifications at higher altitudes should be accomplished from the most comfortable position, which is normally from a stepped down position.

(C) The terminal phase should be executed in the visual identification (VI) mode (flight vector steering) with the F-4J aircraft or the 10-mile scale heat mode with F-4B/N aircraft.

Note

The angle of attack input to the VI mode is not present in any other steering mode. Visual identification of slow speed targets in the 10-mile scale heat mode results in a submarining approach to the target if the effect of angle of attack is not considered.

(C) If the roll out as described in step e. is outside 2 miles, the aircrew should position the F-4 at the ideal starting position which is dead astern the bogey at 1 mile range, co-altitude, and co-speed. From this position a 50 to 100-foot altitude differential, a 25 to 50-knot closure and lateral displacement should be established. The proper lateral displacement from the bogey's flight path results in 4° antenna train angle at 1/2 nautical mile, 8° at 1/4 nautical mile, 16° at 1/8 nautical mile, and the bogey 32° right or left of the nose when the steering dot is displaced approximately 40° in elevation. The F-4 should be stabilized in this last position which is approximately 400 feet slant range from the bogey. If visual contact is not obtained, radar lock should be maintained and a 1-mile radar trail re-established.

WARNING

Transition from night instrument flying to night visual flying requires some night adaptation while stabilized and visually searching for the bogey.

(C)

Note

- Proper lateral displacement may be established by utilizing a variety of methods. One method is a 15° angle of bank turn from the bogey's heading for 3 seconds, then a reversal back to the bogey heading. This results in 20 to 30 feet of lateral offset from the bogey.
- If the VI mode is not available, accurate determination of ranges inside 1/2 nautical mile is extremely difficult.

(U) RADAR TACTICS (ENGAGED)

(C) For close-in combat where the enemy passes intermittently within and out of the radar gimbal limits, the Canopy Code or conventional Clock Code methods should be used to direct the pilot/RIO as appropriate, onto the target. The Canopy Code (figure 1-31) in degrees, is only applicable in relation to the radar scope if the RIO has GYRO OUT selected or the aircraft is in straight and level flight. It also must be realized that the Canopy Code may vary slightly with pilot/RIO head position. The ability to lock on rapidly in close combat is essential. This requires both tuning the radar set properly and utilizing efficient operator techniques. The following tuning procedures are recommended:

a. Pulse mode.
b. Range - 5 to 10-mile scale.
c. Scan switch - NAR/WIDE (AS DESIRED)
d. Receiver gain - turned down to reduce the altitude line until it is just visible (this point must be stressed).
e. Gyro - OUT
f. In the AN/AWG-10, if a forward quarter situation is developing, Pulse Doppler automatic acquisition may be a better method of acquiring the target, and may allow a shot due to faster acquisition and reduced settling time in PD.
g. On F-4N and F-4B/J with VTAS/PLM, both the pilot and RIO have the capability to lock the radar on a target. Utilization of the VTAS/RADAR mode to lock on a target combined with the reduced settling time in the F-4J 1527 configuration radar set will afford more firing opportunities. Also, the pilot can utilize the angle coincidence function of the helmet sight VTAS/RADAR mode discrete light to find a target being tracked by the radar; i.e., with the VTAS/RADAR mode selected, the discrete light illuminates when the pilot's line of sight through the sight reticle is within 3° of the radar antenna look angle.

(C) Target signal return is very critical in obtaining a full system VTAS/RADAR mode lockon and on many occasions sufficient strength cannot be obtained due to minor system malfunctions, target size, look-down angle, or close proximity of the target to the altitude line. The aircrew can easily counter this problem by the pilot utilizing the Half-Action position of the target acquisition enable (TAE) switch and spotlighting the target in azimuth and elevation. The RIO may then position the range gate over the target and acquire.

(U) Full System Lockon (Gyro-Out)

a. RIO positions the elevation strobe up approximately 45°. Pilot maneuvers the aircraft to place the bogey in a plane perpendicular to the wings (split the canopy). While positioning for a boresight lockon, the pilot calls bogey elevation in degrees on the nose and gives trend information as to the bogey movement in elevation.
b. At first contact on the scope, move the elevation strobe down with one rapid roll of the elevation thumbwheel. At the same time, position the acquisition symbol at the necessary range and bearing and squeeze the action switch to Full-Action as the target flies into the B-sweep. It is essential that the bogey azimuth position be maintained at 0° throughout the lock attempt; the pilot accomplishes this by keeping the bogey centered on the canopy while pulling toward the boresight position.
c. If acquisition does not occure, position the elevation strobe down once again and attempt another lock. Continue lockon attempts until the pilot calls boresight or PLM.
d. RIO monitors scope and advises pilot of following, as appropriate:

(1) Lockon
(2) Azimuth
(3) Elevation
(4) Range
(5) Closure
(6) Completion of firing delay (refer to F-4B/N and F-4J AIM-7 Firing Delay, part 2)
(7) Altitude line lock
(8) Break lock

Note

If the RIO knows the bogey elevation relative to the horizon, acquisition will be facilitated by the use of Gyro-In. The greatest advantage of Gyro-In is that once the bogey is detected, elevation will not have to be adjusted to compensate for F-4 pitch or roll excursions.

(U) Pilot Lockon Modification (PLM) - F-4B/N

(C) The Pilot Lockon Modification (PLM) supplements and enhances the capabilities of the AN/APQ-72 radar system. If the RIO is unable to acquire and lock on a target in an ACM environment due to high G forces, incapacitation, or any one of many factors, the pilot has the capability to acquire a target and launch an AIM-7 missile.

(C) PLM on F-4B without VTAS is utilized as follows:

a. The pilot visually boresights the target.
b. The pilot presses the nose wheel steering button.
c. The AN/APQ-72 radar switches to boresight mode - heavy clutter - 5-mile scale.
d. The range strobe sweeps in from 5 miles to 1/4 mile or out from 1/4 mile to 5 miles, dependent upon the position of the sweep select switch (IN/OUT) on the Bullpup panel.

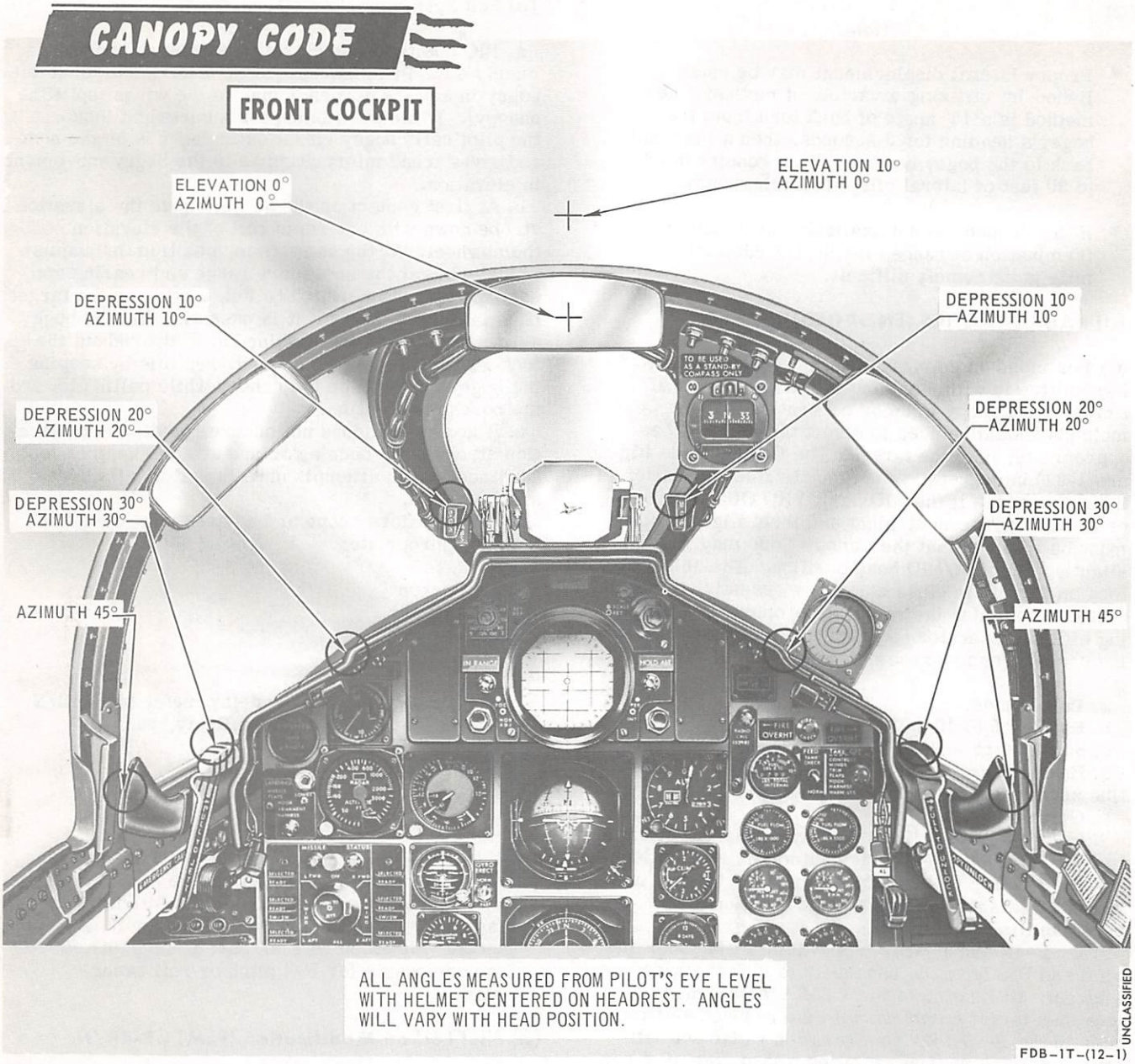


Figure 1-31 (C) (Sheet 1 of 2)

(C)
e. As the range strobe sweeps through the target, the radar automatically acquires the target and switches to full automatic track.

f. If acquisition does not occur, the range strobe continues to sweep in the direction selected until the target is acquired or the nose wheel steering button is released.

NEW NEW (C) PLM on F-4N and F-4B with VTAS is utilized as follows:

a. Track switch - AUTO
b. Sweep select switch - AS DESIRED
c. VTAS mode switch - SEAM/PLM
d. Missile select switch - RADAR
e. Pilot boresights target.

f. Press TAE to Half-Action. The radar switches to boresight - heavy clutter - 5-mile scale.

(C) For automatic lockon:

g. Press TAE to Full-Action. The range strobe sweeps in from 5 miles to 1/4 mile or out from 1/4 mile to 5 miles, dependent upon the position of the sweep select switch (IN/OUT) on the Bullpup panel.

h. As the range strobe sweeps through the target, the radar automatically acquires the target and switches to full automatic track. The TAE may be released.

i. If acquisition does not occur, the range strobe continues to resweep in the direction selected until the target is acquired or until the TAE is released.

NEW NEW NEW NEW NEW

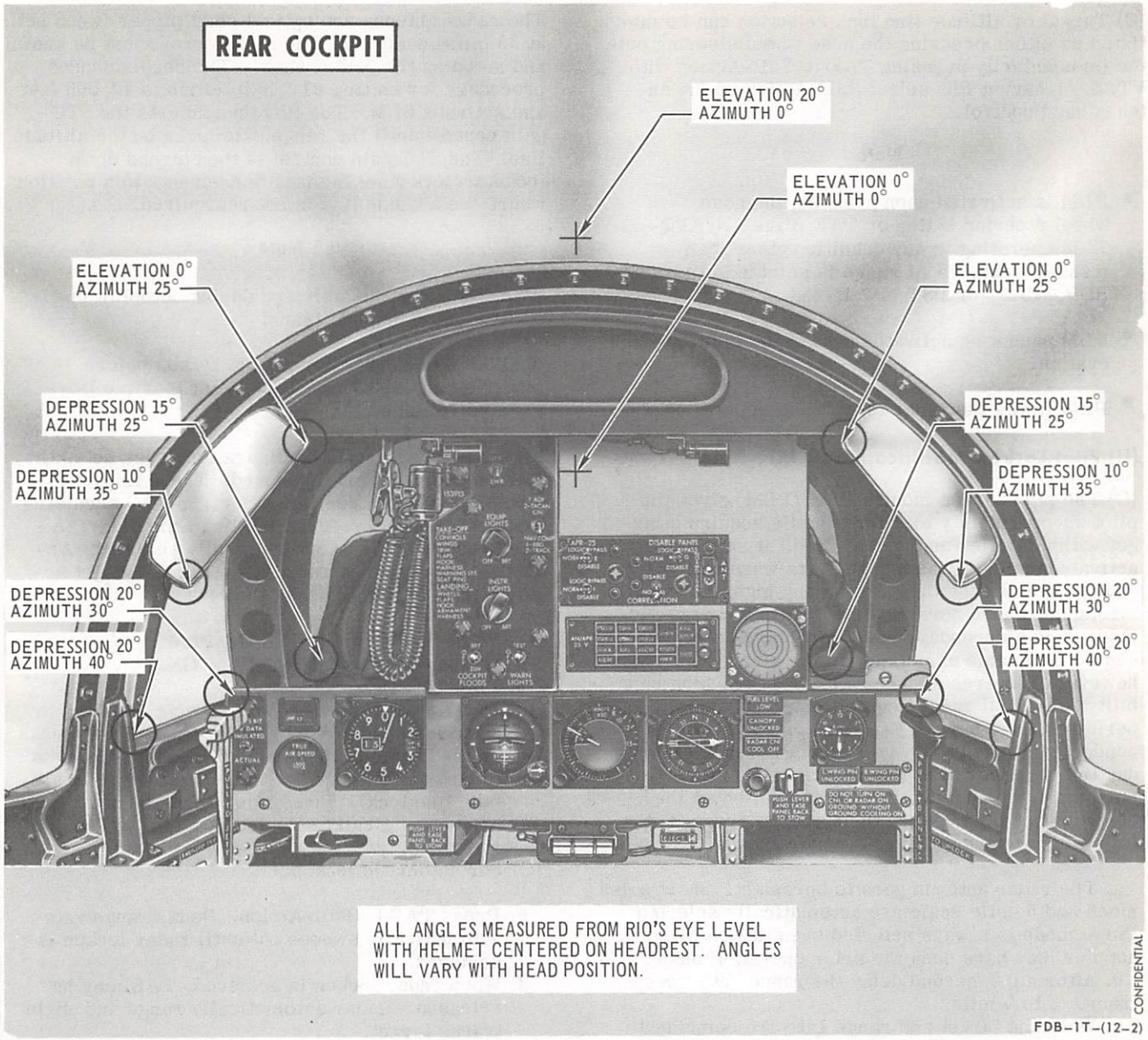


Figure 1-31 (C) (Sheet 2 of 2)

(C)

Note

For automatic lockon, the TAE may be pressed immediately to Full-Action after the target is boresighted. Range gate sweep and radar lockon are not enabled until the antenna is within 3° of boresight.

(C) For manual lockon:

j. After boresighting target, pilot only presses TAE to Half-Action and holds; RIO presses action switch on antenna hand control to Half-Action to obtain manual control of range gate.

k. Move range strobe over target in B-sweep with antenna hand control and press action switch to Full-Action to lock radar on target.

l. When radar lockon is achieved, TAE and action switch may be released. Radar automatically range and angle tracks target.

(C) On all F-4B/N, RIO monitors radar scope and advises the pilot of the following as appropriate.

a. Lockon.
b. Range
c. Closure
d. Completion of firing delay (refer to F-4B/N and F-4J AIM-7 Firing Delay, part 2)
e. Altitude line lock
f. Break lock

(C) Target or altitude line lock rejection can be initiated by either pressing the nose wheel steering button (momentarily pressing TAE to Full-Action with VTAS) or having RIO select Half-Action on the antenna hand control.

Note

- PLM is activated upon pressing the nose wheel steering button or TAE if the AN/APQ-72 is operating in any condition other than manual track, an AI range is selected, and RDR, MAP, or BST is selected.
- PLM cannot be activated during autopilot operation.
- PLM limits the radar to back bias operation.

(U) Pilot Lockon Modification (PLM) - F-4J

(C) The pilot lockon modification (PLM) gives the pilot an opportunity to automatically acquire a target within 5 miles and boresighted. It should be activated during ACM engagements when the RIO fails to acquire the target or in any high clutter environment where normal pulse lockon is impracticable. It is a secondary mode of radar operation but can be a valuable assistance to the aircrew. PLM, however, requires an accurate target tracking capability for initial radar acquisition. Therefore, periodic target boresighting exercises should be conducted by the pilot. To select PLM on F-4J without 1527 configuration radar sets, the pilot need only press the nose wheel steering button on the control stick grip. When the button is pressed, the following sequence of events occurs:

a. The radar antenna goes to boresight. Short pulse mode and 5-mile scale are automatically selected. Pulse mode is always selected even though pulse doppler may have been the prior operating mode.
b. After a 0.5-second delay the range gate sweeps from 1/3 to 5 miles.
c. When the target and range gate are coincident, full system radar track commences. If the range gate fails to acquire the target on the first sweep, it will return to 1/3 mile and resweep to 5 miles until lockon occurs or the nose wheel steering button is released.

Note

Break lock is accomplished by either selecting Half-Action on the antenna hand control or by momentarily pressing the nose wheel steering button.

(C) Altitude line video (side lobe clutter) is reduced by addition of STC (sensitivity time control) circuits. In effect, STC eliminates altitude line lockon. STC is controlled by a guarded gain pot located around the erase button on the radar set control.

(C) Effective utilization of PLM requires that the aircraft be properly boresighted and the STC gain control be adjusted to eliminate altitude line lockon. The radar antenna and optical sight pipper (when set at 35 mils) must coincide or the error must be known and noted on the yellow sheet. The recommended procedure for setting STC is to climb to 12,000 feet and activate PLM. The RIO then adjusts the STC gain control until the range gate locks on the altitude line. The STC gain control is then turned down (counterclockwise) in small increments to a position where the altitude line is not reacquired.

Note

- PLM cannot be activated during autopilot operation or manual track.
- Wait 4 seconds after a PLM lockon before firing an AIM-7 missile. Refer to Time Delays, this section.

(C) On F-4J with 1527 configuration radar sets, the PLM capabilities are improved. These improvements include altitude line reject, high-G acceleration limits, and a reduced settling time delay. A fixed receiver STC is automatically selected. Acquisition procedures are also changed. Target acquisition is accomplished as follows:

a. VTAS mode switch - SEAM/PLM
b. Weapon select switch - SP or GN
c. Pilot boresights target
d. Press TAE to Half-Action. Radar attempts to acquire altitude line to prevent range gate locks on the altitude line and then the antenna slaves to boresight (there are no indications of an altitude line lock). Five-mile range and short pulse are automatically selected.

(C) For automatic lockon:

e. Press TAE to Full-Action. Radar range gate automatically sweeps out until radar lockon is achieved.
f. When radar lockon is achieved, TAE may be released. Radar automatically range and angle tracks target.
g. If the range gate fails to acquire the target, it returns to 0.45 mile and resweeps to 5 miles until lockon occurs or until the TAE is released.

Note

For automatic lockon, the TAE may be pressed immediately to Full-Action after the target is boresighted. Range gate sweep and radar lockon are not enabled until the antenna is within 3° of boresight.

(C) For manual lockon:

h. After boresighting target, pilot presses and holds TAE in Half-Action and RIO presses action switch to Half-Action to obtain manual control of range gate.
i. Move range strobe over target in B-sweep with the antenna hand control and press action switch to Full-Action to lock radar on target.

(C)
j. When radar lockon occurs, TAE and action switch may be released. Radar automatically range and angle tracks target.

(C) Lockon can be rejected by momentarily pressing the TAE or action switch to Half-Action.

Note

On F-4J aircraft with 1527 configuration radar sets, wait 1.5 seconds after a PLM lockon before firing an AIM-7 missile. Refer to F-4B/N and F-4J AIM-7 Firing Delay, this section.

(U) VTAS/Radar Mode - F-4B/N and F-4J

(C) With VTAS, the pilot has the option of locking the radar on a target within 5 miles that is not necessarily boresighted. VTAS eliminates the requirement for accurate target tracking through the gunsight. It also can be utilized to direct the RIO onto the appropriate target without using the Canopy Code or conventional Clock Code methods. To utilize the VTAS/RADAR mode, the following radar switch settings are required. For F-4J, the radar function switch must be in OPR. For F-4B/N, the radar power switch must be in OPR, an AI range selected, the track switch in AUTO, and the radar mode switch in RDR, MAP, or BST (after AVC 679). Also the pilot may select the range gate sweep direction with the sweep select switch on F-4B/N aircraft. With these conditions satisfied, target designation and acquisition is accomplished as follows:

a. VTAS mode switch - VTAS
b. VTAS power switch - ON
c. Missile select switch - RADAR (F-4B/N)
   Weapon select switch - SP or GN (F-4J)
d. Look at target and center it on helmet sight reticle.
e. Press TAE to Half-Action and spotlight target. On F-4J, radar attempts to acquire altitude line and then the antenna slaves to pilot's line of sight; 5-mile range and short pulse are automatically selected. On F-4B/N, radar antenna slaves to pilot's line of sight and 5-mile range is automatically selected.

(C) For automatic lockon:

f. Press TAE to Full-Action.
g. Radar range gate automatically sweeps until target lockon is achieved. For F-4B/N, the range gate sweep limits are from 1/4 mile to 5 miles. For F-4J, the range gate sweep limits are from 0.45 to 5 miles.
h. When radar lockon discrete light (lower right light) illuminates, TAE may be released. Radar automatically range and angle tracks target.

Note

For automatic lockon, TAE may be pressed immediately to Full-Action after the pilot centers the target on the helmet sight reticle.

(C) For manual lockon:

i. After centering target on helmet sight reticle, pilot presses and holds TAE in Half-Action and RIO presses action switch to Half-Action to obtain manual control of range gate.
j. Move range strobe over target in B-sweep with antenna hand control and press action switch to Full-Action to lock radar on target.
k. When radar lockon occurs, TAE and action switch may be released. Radar automatically range and angle tracks target.
l. To visually re-acquire target being tracked by radar, note antenna position from scope indications and visually scan this area of space. VTAS/RADAR discrete light (upper right light) illuminates when pilot's line of sight is within 3° of the radar antenna look angle. Target should be along this line of sight.

(C) Target lockon may be rejected by momentarily pressing the TAE to Half-Action (F-4J) or Full-Action (F-4B/N). The RIO may reject lockon by momentarily selecting Half-Action with the action switch. When lockon is rejected, the radar returns to the mode and condition of operation it was in prior to initiation of target lockon.

Note

On F-4J aircraft with 1527 configuration radar sets, wait 1.5 seconds after a radar lockon before firing an AIM-7 missile. On F-4B/N and all other F-4J wait 4 seconds. Refer to F-4B/N and F-4J AIM-7 Firing Delay, this section.

(U) Boresight Acquisition

(C) For a boresight lockon, the pilot will call GO BORESIGHT as the target comes on the gunsight. The RIO will switch to the boresight mode while the pilot continues to position the pipper on the target to ensure bogey illumination on the B-sweep. The RIO will have set the gain, selected Half-Action, and positioned the range gate above the main bang awaiting the target to appear in the B-sweep. When the target appears, place the acquisition symbols over the target while going to Full-Action. When the attack display appears, switch out of boresight mode and call LOCKED UP. The RIO's left hand should be on the mode switch any time he has selected boresight in order to decrease the time required to return to full automatic system. On F-4B/N after AVC 679 or on F-4J with 1527 configuration radar sets and all other radar sets after AVC 852, the radar automatically switches to full automatic track after lockon. On F-4N and F-4B with the target aspect switch installed, the target aspect switch should be set to the position representative of the V_c in case lockon does not occur.

(C)

Note

- To ensure that a bogey will appear on the B-sweep when positioned within the 50/60 mil ring, it is highly recommended that prior to entering an enemy threat zone, a boresight check on another aircraft within the flight be conducted to ensure the flight crew knows actual aircraft boresight.

- The speedgate will be in narrow sweep (gate switch in NAR/NORMAL) and interlocks will be out with the radar system in automatic track and boresight selected. On F-4B/N aircraft, english bias is grounded out when the mode switch is in BST.

(U) VISUAL SIGHTINGS

(U) When an aircraft has been positively identified as an enemy, a transmission must be made immediately to all friendly aircraft. The TALLYHO call must be made immediately over UHF. Crewmembers cannot waste time reporting visual or radar contacts over ICS.

CALL SIGN	TOPGUN ONE TALLYHO
DETECTION	BOGEY (BANDIT)
DIRECTION	RIGHT 2 O'CLOCK
ELEVATION (relative to horizon)	30 HIGH
RANGE	3 MILES
RESPONSE	TOPGUN TWO TALLYHO OR NO JOY

WARNING

Contacts detected close in (usually less than 3 miles) require immediate tactical maneuvering. In these cases the maneuver call comes first and an abbreviated TALLYHO report follows. Typical example:

TOPGUN HARD RIGHT,
TOPGUN 2 SPLIT HIGH, BURNER, MIGS COMING TO THE NOSE AT 1 MILE

(U) For more detailed information refer to Loose Deuce UHF Transmission, discussed later in this part.

(U) TACTICAL ORGANIZATION

(C) Once the decision to engage has been made and a specific bogey has been selected for attack, the fighters must keep the fight organized to avoid delays or confusion which result in the loss of an initial advantage or mutual support. Organization consists of: (a) defining to enemy to be attacked and (b) designating the engaged fighter and the free fighter in order to establish responsibilities.

Note

The fighter aircrew must spend many hours in thought to mentally place themselves in every conceivable circumstance of combat, both offensive and defensive. Then when any specific circumstance arises in combat, they will have one or more predetermined courses of action to implement at the right time or place.

(U) ENGAGED AND FREE FIGHTER OBJECTIVES

(C) The engaged fighter's primary objective is to kill or to control the bogey. While never passing up a valid shot, the engaged fighter's role is that of achieving or forcing the opponent into a predictable flight path or maneuver which allows the free fighter to gain the quick kill.

(C) The free fighter's primary objective is to kill the bogey and to direct the action of the engaged fighter while providing close support (cover). He should split out of the maneuvering plane-of-action employed by the engaged fighter while maintaining a high energy level. He should strive to keep sight of the entire fight and work toward the missile envelope for the kill. The free fighter should determine what he requires for the quick kill and direct the maneuvering of his engaged fighter while keeping him informed of his position and intent. Examples of this control by the engaged fighter and direction by the free fighter is best illustrated in terms of the initial position beginning the engagement:

a. Offensive (as generated by a stern conversion intercept). Given a position advantage at the outset, the engaged fighter should attack the bogey striving to gain the kill if possible or, if unable due to relative energy rates, to pressure the bogey into a definite, defensive plane of maneuvering. The initial offensive position advantage of the engaged fighter may be prolonged by the use of lag pursuit. The free fighter should maneuver to bracket the bogey at the earliest opportunity. This is best achieved by maneuvering out of the engaged plane of action and rolling in for the kill on the belly or blind side of the target. If unable to achieve the bracket and if bogey flight path reversal is desired to set up a quick kill by the free fighter, a planned overshoot by the pressing engaged fighter utilizing a lead or pure pursuit curve attack may be used. This should only be attempted under the conditions of high angle-off and a distinct airspeed advantage on the part of the engaged fighter. In no case should the engaged fighter allow his attack to degenerate into a close-in, slow-speed dogfight with a low wing loaded bogey when team tactics and the offensive use of both F-4's proves far safer and more effective.

b. Neutral (as generated by a head-on intercept). If unable to maneuver for the stern of the selected bogey, the engaged fighter should turn in to meet the bogey head-on with minimum lateral separation. When possible, it is desirable to bracket the bogey at the outset, generating as much of a lookout problem for him as possible. As the bogey passes, determine whether he intends to engage or to continue for the split free fighter. Should he turn to fight the

(C) engaged fighter, the free fighter should maneuver immediately for the blind cone of the bogey. If the bogey elects to continue for the free fighter, a position advantage should develope for the engaged fighter. Subsequent maneuvering will dictate a reversal of roles in this case, with the initial free fighter becoming engaged.

c. Defensive. When engaging with a position disadvantage and at such range that a head-on pass cannot be accomplished by either F-4, extension tactics may apply at the very start. While not the optimum, the engaged fighter can still fulfill his responsibility to influence the bogey's flight path by dragging the bogey out for the free fighter's kill. This implies that the proper range separation is achieved by the engaged fighter to preclude a guns or missile shot by the threatening bogey. Should the initial range be such that the extension maneuver cannot be safely employed, a hard or break turn and associated last ditch maneuvering may be necessary for the engaged fighter. In either case, the free fighter should endeavor to sandwich the bogey at the earliest opportunity and get the kill as quickly as possible.

(U) Engaged Fighter Responsibilities

(C) The responsibilities of the engaged fighter are:

a. Kill the bogey.
b. Force the bogey into a predictable flight path.
c. Force the bogey to a low energy level.
d. Force the dogfight to low altitude.
e. Keep the bogey in sight.
f. Deny the bogey the opportunity to effectively employ his weapons system.

(U) Free Fighter Responsibilities

(C) The responsibilities of the free fighter are:

a. Kill the bogey.
b. Deny any bogey the opportunity to effectively employ his weapons system.
c. Clear the engaged fighters 6 o'clock.
d. Call the engaged fighter's maneuvers to optimize the chance for a kill.
e. Maneuver to the bogey's blind cone.
f. Predict the bogey's flight path and maneuver aggressively for the missile launch zone.
g. Maintain a high energy level.
h. Maneuver out of the bogey's plane of turn; i.e., use the vertical relative to the target, rather than accepting a close-in, slow-speed fight if the bogey switches.
i. Avoid a position across the circle from the target (Lufbery).
j. Always inform the engaged fighter, if at any time, the free fighter must go defensive against a second bogey.

(U) LOOSE DEUCE UHF TRANSMISSIONS

(U) Strict radio discipline in air combat is mandatory. There will only be time to make a transmission once. Those intended to receive the transmission must be able to filter out what has been said, and by whom, over the myriad of audio signals being funneled into the headset: i.e., SAM/MIG warnings, flight instructions, missile tone, etc. If you have something to say, make it brief, clear, and concise. All ACM tactical transmissions while engaged must be acknowledged.

(C) Each F-4 must let his wingman know how the engagement is progressing from his viewpoint and situation. It is imperative that calls of intent (I'M PITCHING BACK STARBOARD) as well as calls of information and direction (I'M AT YOUR 5 O'CLOCK LOW, BOGEYS AT MY 7 O'CLOCK LOW, COME BACK STARBOARD FOR A SHOT) be given. Both aircraft must have some idea of the other's problem and intentions to support each other. In a tough fight, the quality of the UHF calls is more important than the quantity. The most important call from the engaged fighter is the bogey's position. The most important calls from the free fighter are his position, intentions, and recommendations to the engaged fighter. There is no one correct UHF format. Use the radio to keep the fight organized. Both fighters must know who is engaged and who is free, where each fighter is in relation to the other, and where the bogeys are.

(C) When making a UHF transmission, use your call sign. A command from TACLEAD (Topgun One) to his wingman (Topgun Two) would read: TOPGUN TWO PITCH BACK. UHF calls from the RIO will use the flight (TOPGUN) call while ICS calls should use first names. Critical to effective section tactics are short clear UHF transmissions. The following calls are recommended:

TOPGUN ONE ENGAGED - Topgun One is forcing enemy aircraft to maneuver against him. Implies that Topgun Two is free and should go for launch zone immediately.

TOPGUN TWO FREE - Topgun Two is free fighter.

TOPGUN TWO OFF - Topgun Two has stopped pressing the bogey and is repositioning based on the tactical situation.

TOPGUN ONE IN - Topgun One is commencing attack and is positioning for launch zone.

TOPGUN TWO YOUR SIX IS CLEAR - Self explanatory.

TOPGUN TWO PRESS HIM - Continue to press attack on bogey.

TOPGUN TWO YOUR BOGEY SWITCHED - The bogey attacking Topgun Two has switched his attack.

TOPGUN TWO LAG PURSUIT - Use lag pursuit techniques.

(C)

TOPGUN ONE REVERSE - A call that Topgun One turn direction is the wrong way; bogey overshoot may have occurred. Topgun One executes a 180° roll reversal and pulls in opposite direction.

TOPGUN TWO COME BACK LEFT/RIGHT - A call from Topgun One that a 200° heading change is needed to bring Topgun Two back toward fight. Implies turn is to be made in the plane of the initial path. Thus, a comeback to Topgun Two in a 30° nose up flight path would be made in that 30° nose up plane. Can be modified by COME BACK HIGH or COME BACK LOW.

TOPGUN TWO PITCH BACK LEFT/RIGHT - Execute a 200° heading reversal in the near vertical plane (an oblique loop off the pure vertical as necessary).

TOPGUN TWO LAST DITCH - Refer to Last Ditch Maneuvering. Topgun Two is under gun threat and must spoil tracking solution. BREAK GUNS call has already been made.

TOPGUN TWO EXTEND - Do not reverse but extend to gain more fighting room.

NEW TOPGUN TWO BUGOUT - Meet threat as near head-on as possible, unload, and regain fighting room or leave fight. Do not lose sight of bogey.

(C) In addition, avoid the 6 o'clock call; either call 5 or 7 or inside or outside to give your wingman a clear picture of the best direction to look or turn.

(U) UHF Jamming

NEW NEW NEW NEW NEW (C) In the event the enemy effectively jams the Loose Deuce section's UHF transmissions, the fighter's mutual support will be degraded. Switching to a pre-briefed secondary frequency may solve the problem. If the fighters are unable to use UHF, they must make the decision to remain engaged or to disengage. If they elect to remain engaged, the following tactical considerations should be made:

a. Each fighter is completely responsible for clearing his own 6 o'clock.
b. If the fighters become separated they should consider disengaging immediately as prebriefed.
c. A prebriefed communications plan must insure both fighters return to their primary frequency if unable to establish contact on the prebriefed secondary frequency(s).

(C) LOOSE DEUCE VISUAL RESPONSIBILITIES

a. Both F-4's should strive to acquire the bogeys on the initial pass.
b. Each F-4 should strive to keep his own threat in sight, and the section together should have sight of all bogeys. Individual F-4's will not be able to maintain sight of all bogeys at all times. Consequently, the responsibility for each RIO to "clear his six" any time the pilot is not actively maneuvering against his threat is mandatory.
c. TACLEAD must keep his own threat in sight and also keep his wingman's threat in sight. This allows TACLEAD to maneuver offensively against his wingman's threat at the earliest possible opportunity.

(U) VISUAL ENGAGEMENT

NEW (C) When visually engaged, a large majority of the RIO time is spent keeping the enemy in sight. He also can supply valuable information to the pilot on altitude, attitude, and airspeed. It should be noted that the RIO visibility aft is significantly greater than the pilot's. RIO narration on the bogey should be crisp, precise, loud, and accurate. Four elements regarding the bogey that the RIO should portray to the pilot are:

a. Relative position
b. Range
c. Closure
d. Relative attitude

NEW (C) As the bogey comes well within the radar gimbal limits (about 45°) and the pilot confirms visual contact, the RIO may return to the scope and attempt lockon. If lockon has not occurred and the bogey is approaching the nose, the pilot may call the RIO for a boresight lockon or utilize the pilot lockon modification (PLM) to acquire the target. In either case, the pilot must accurately track the target with the fixed pipper depressed 35 mils. On aircraft with VTAS, the pilot can slave the radar antenna onto the bogey by utilizing the helmet sight. Refer to VTAS/Radar Mode, this section.

(C) SECTION GUIDELINES

a. Force the bogeys to commit themselves early.
NEW NEW b. Do not split the section to fight one-on-one. It is important that the free fighter maneuver aggressively and be ready to exchange roles with his wingman. The free fighter is wasted if he allows his wingman to engage in one-on-one combat when a two-on-one fight is possible.
c. Mutual support in a loose deuce section dictates that:

(1) The F-4's are separated enough to preclude being attacked as a single unit.
(2) This separation is such that either F-4 can rapidly achieve the ACM launch zone on an enemy attacking a teammate.
(3) This separation is not so great that visual contact with the fight can be lost or a rapid reattack precluded.

NEW d. These factors necessitate the following:

(1) Maximum separation between the fighters should be no greater than 3-4 miles.
(2) Minimum lateral separation between F-4's in a fight on a co-heading is 2 miles.

(C)

(3) The free fighter controls the separation once the section is engaged. If the free fighter puts his nose on a bogey without a shot opportunity, he will close to minimum range and will have to pitch off to reposition, wasting valuable time. Conversely, if the free fighter's nose is too far from the fight (in angle), it will take too long to get into the fight. The free fighter should operate in a plane perpendicular to the plane of turn of the fight.

(4) If the F-4's pass head-on, one or both must maneuver rapidly to avoid exceeding maximum separation and losing sight of the fight.

NEW e. The best chances for a kill are during the initial maneuvers. Any bogey engaging the first F-4 should become a quick target for the free fighter. Once the engagement gets involved, the determination of the free fighter and engaged fighter becomes increasingly difficult.

NEW f. At all times, the F-4's must maneuver to neutralize any immediate threat. One F-4 must go offensive. Each F-4 should maintain enough separation from his bogey to allow him to:

(1) Keep the bogey out of his lethal envelopes (guns/missiles).

(2) Keep the bogey at a distance which will allow a reversal and a run through without the bogey becoming an immediate threat. This provides an opportunity to gain an offensive position.

NEW g. Anticipate your next move. PLAN AHEAD. Maneuver your aircraft to force the bogey between you and the other fighter.

NEW h. In a multiple bogey environment, it must be assumed that the bogeys will split and actively pursue each F-4. A general concept which can aid in setting up shots is to maneuver to put your bogey in a position which will allow your wingman to reverse into his bogey, run through him, and attempt to gain a shot at your bogey. In other words, try to take your bogey through your wingman's 6 o'clock in a direction not aligned with his flight path.

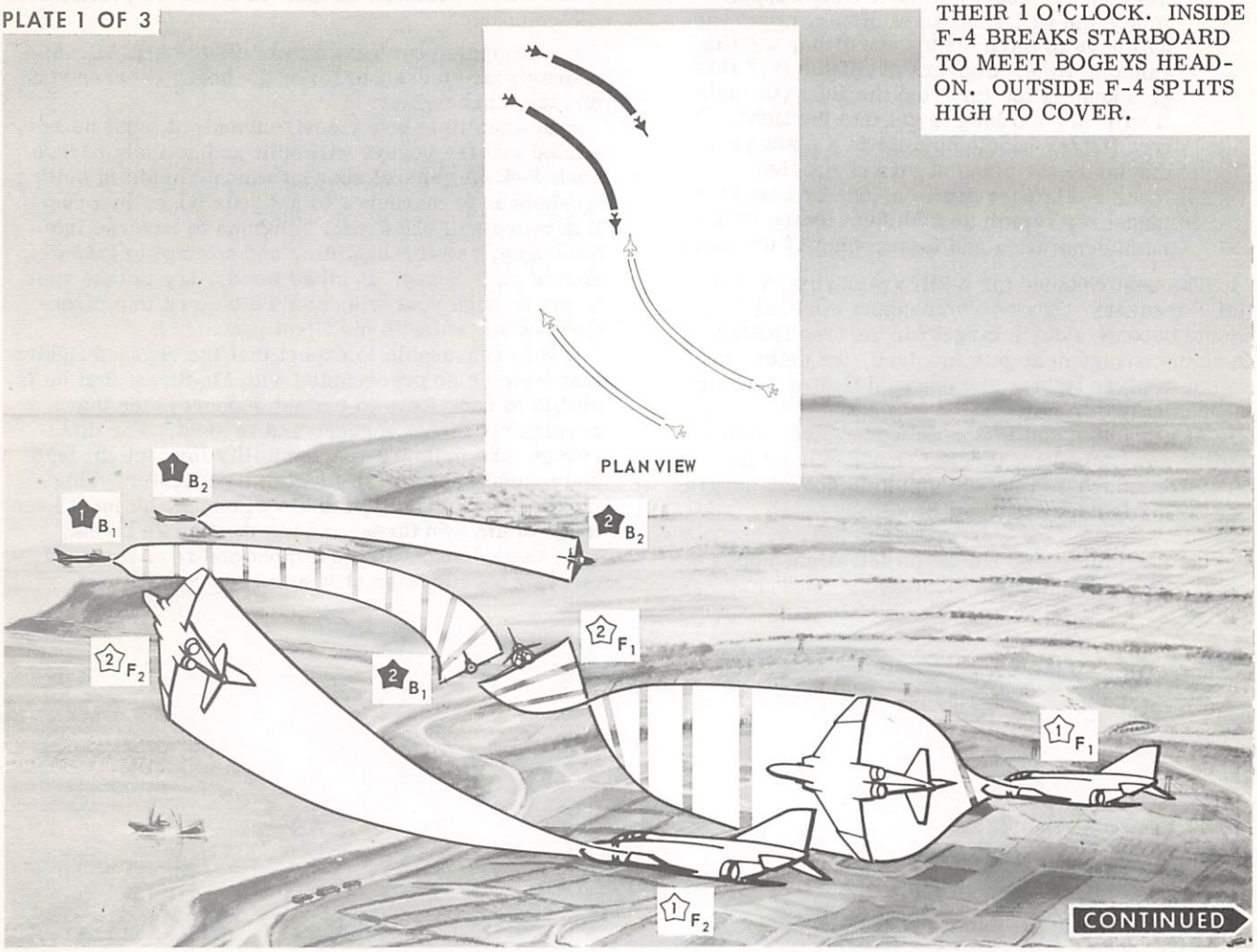
NEW i. It is reasonable to expect that the engaged fighter may become so preoccupied with his threat that he is unable to contribute to mutual support other than keeping his threat engaged and in sight. For this reason, the primary responsibility for tactical lead and mutual support falls on the free fighter. This means that, in addition to his wingman, he must keep track of his own threat and his wingman's threat. This taxes lookout to the utmost and requires good aircrew coordination of visual responsibilities.

LOOSE DEUCE OFFENSIVE TACTICS

PLATE 1 OF 3

SITUATION I:

F-4'S SIGHT BOGEYS AT THEIR 1 O'CLOCK. INSIDE F-4 BREAKS STARBOARD TO MEET BOGEYS HEAD-ON. OUTSIDE F-4 SPLITS HIGH TO COVER.



TACTICAL CONSIDERATIONS

AT 1: Closest fighter (F_1) can put his nose on either bogey. F_1 turns to engage. Outside fighter (F_2) should increase the split between the fighters using both vertical and horizontal separation, to assume a cover position. If the first bogey through (B_1) doesn't go for F_1 after the initial head-on pass, he must "drive" at low-G to get to F_2. The split has negated the bogey's superior rate and radius of turn. F_2 should keep F_1 informed of his position: 'I'M AT YOUR 7 O-CLOCK HIGH".

TECHNIQUES

AT 1: F_1 turns hard and selects afterburner to gain as much performance as possible prior to the head-on pass with B_1. F_1 should turn a little past the line of sight to B_1 to cause a port-to-port pass, allowing more than minimum lateral separation. The reasons are: (1) to suck B_1 into turning after F_1, giving F_2 a quick kill opportunity, and (2) to allow F_1's RIO to keep B_1 in sight, as the pilot must transfer his attention to B_2.

F_2 selects full afterburner and commences a gentle climbing starboard turn to cause an offensive split. F_2 must not bleed energy, but should use maximum climb possible. F_2 should judge the turn to get maximum separation (minimum turning) but turn far enough so his nose is not too far away from the head-on pass. If B_1 goes for F_1, F_2 will have a quick shot opportunity.

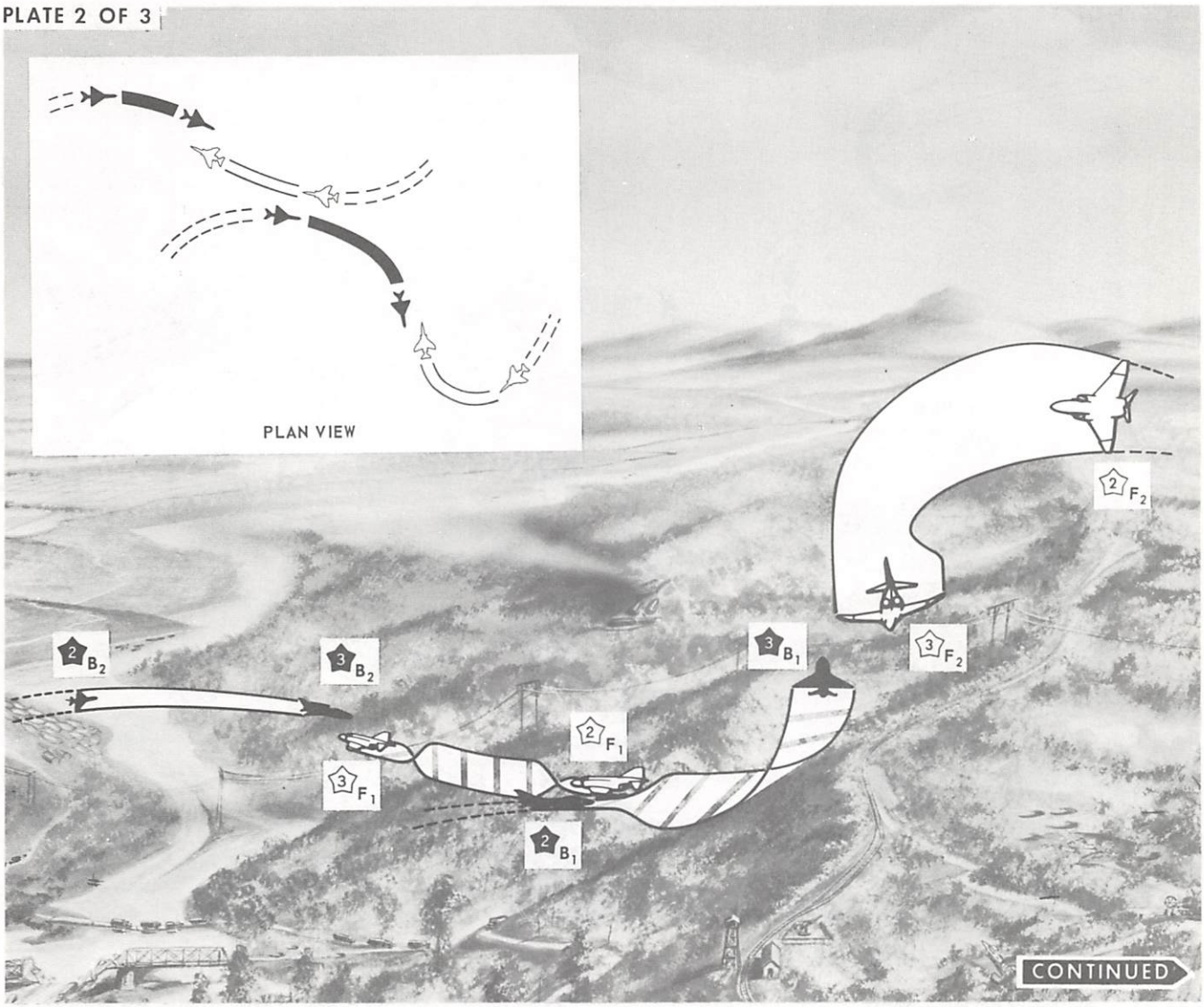
FDB-1T-(35-1) CONFIDENTIAL

Figure 1-32 (C) (Sheet 1 of 6)

LOOSE DEUCE OFFENSIVE TACTICS

SITUATION I
-Continued-

PLATE 2 OF 3



TACTICAL CONSIDERATIONS

AT (2): B_1 doesn't take the preferred lateral separation on the port-to-port pass with F_1 and continues up and starboard to meet F_2. F_1 can not pitch up or turn after B_1 either, and continues easy starboard to meet B_2.

Note

The value of the offensive split can now be seen. F_1 will meet B_2 first. F_2 can then dictate his moves against B_1 as a result of B_2's maneuvering.

TECHNIQUES

AT (2): F_1 has enough separation in the head-on pass for the RIO to keep sight of B_1, regardless of what B_1 does. The pilot must devote his attention to B_2. As B_1 maneuvers for F_2, UHF call may be as follows: (F_2) - FIRST BOGEY HAS SWITCHED UP TO ME. (F_1) - ROGER, I'LL MEET NUMBER 2 HEAD-ON. (F_2) - OK, MAKE HIM TURN ON YOU. I'LL MEET NUMBER 1 HEAD-ON AND BE IN FOR NUMBER 2.

F_2 now turns hard starboard and down into B_1 and has the entire fight in front of him. As F_1 develops the starboard-to-starboard pass with separation, B_2 commits onto him.

CONFIDENTIAL

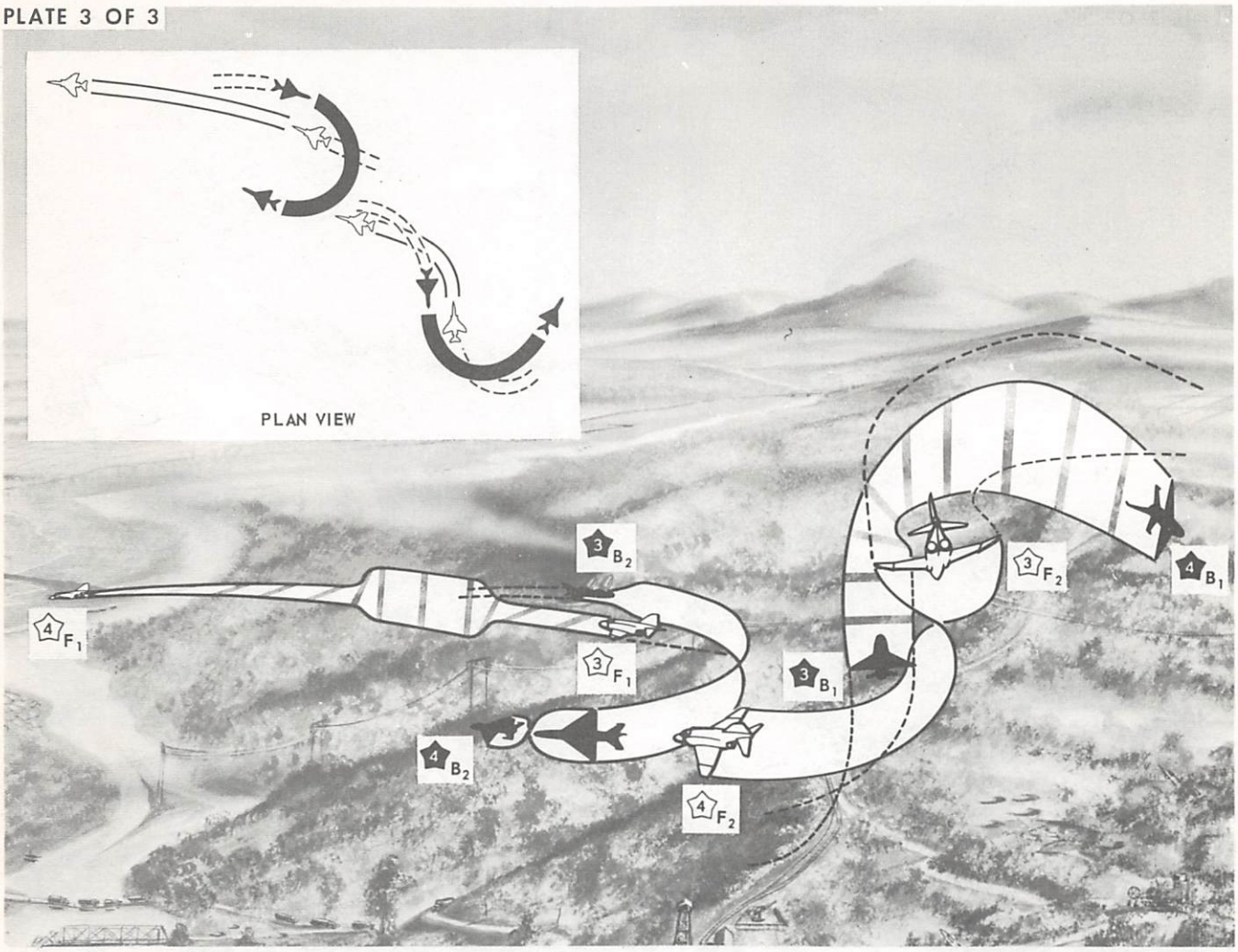
FDB-1T-(35-2)

Figure 1-32 (C) (Sheet 2 of 6)

LOOSE DEUCE OFFENSIVE TACTICS

SITUATION I
-Continued-

PLATE 3 OF 3



TACTICAL CONSIDERATIONS

AT 3: As F_2 sees B_2 commit starboard after F_1, he sets up port-to-port with B_1. By taking out the lateral separation on B_1, F_2 has negated B_1's threat. B_1 is now forced to turn at least 180° to get back into the fight, which is going away from him. F_2 knows he will come easy port for the kill, and committing B_1 into a port reversal will give B_1 the longest way around. If the lateral separation on B_1 was not taken out as F_2 went in for the shot, B_1 would rendezvous as F_2 went by, using lead pursuit and an early turn, and would become the greatest threat.

Offering F_1's stern to a bogey (out of range) is acceptable to produce a desired result. A kill by either fighter on the high threat bogey is acceptable, sought after, and the objective of the engagement. A quick kill over hostile territory is obviously the safest for the section. The illustrated situation has demonstrated one quick kill technique.

TECHNIQUES

AT 3: F_2 sets up a port-to-port pass on B_1. B_1 is committed to a port turn in his reversal and is "spit out" of the fight as F_2 comes easy port.

As B_2 commits on F_1, he comes quickly hard port to gain sight of B_2, then straightens out. This will roll the bogey's wings level after about 150° of turn, and F_2 will be looking at B_2's "dead six" with a very low target G.

After the kill on B_2, both fighters turn in place starboard to engage B_1.

CONFIDENTIAL

FDB-1T-(35-3)

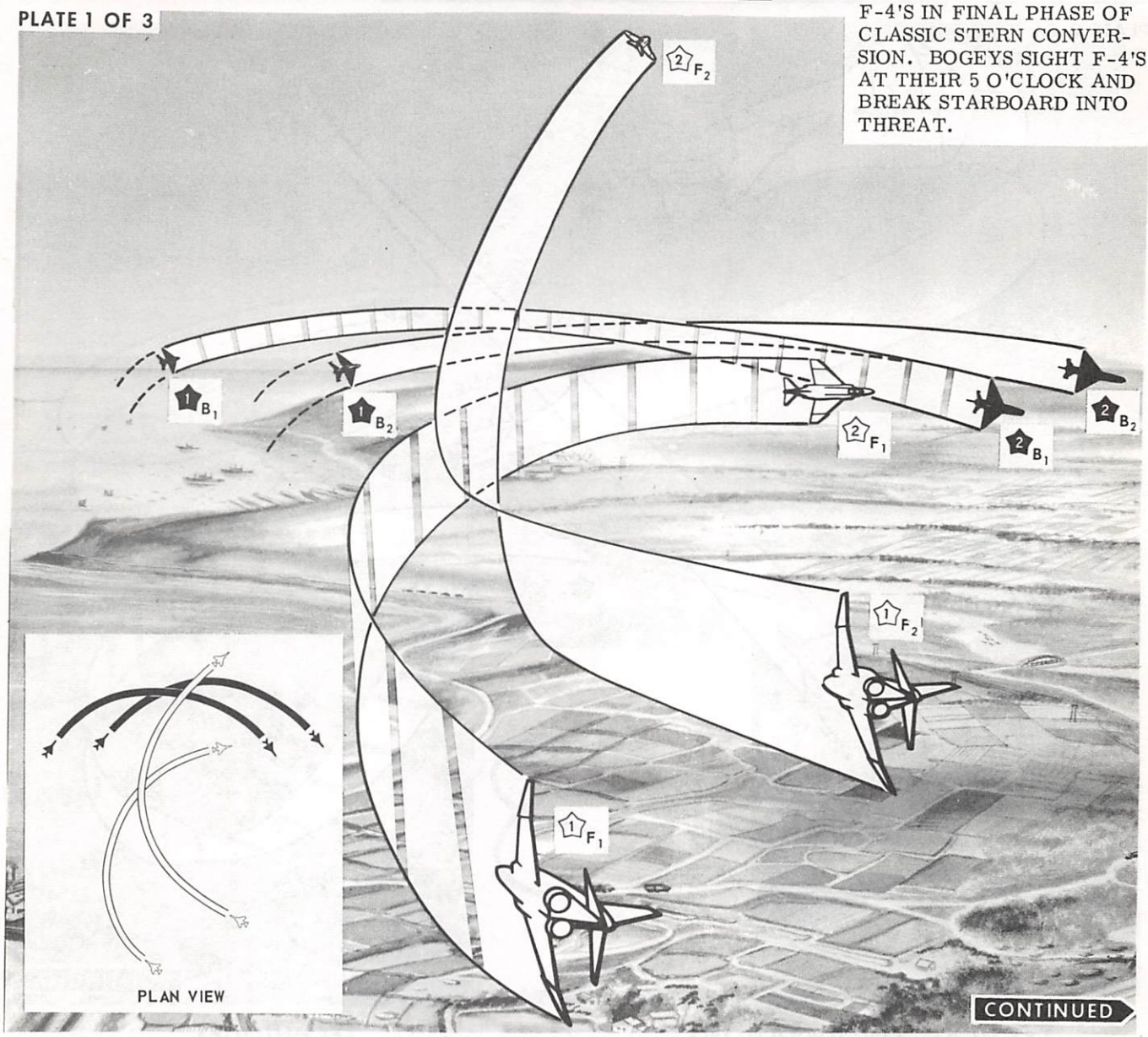
Figure 1-32 (C) (Sheet 3 of 6)

LOOSE DEUCE OFFENSIVE TACTICS

PLATE 1 OF 3

SITUATION II:

F-4'S IN FINAL PHASE OF CLASSIC STERN CONVERSION. BOGEYS SIGHT F-4'S AT THEIR 5 O'CLOCK AND BREAK STARBOARD INTO THREAT.



TACTICAL CONSIDERATIONS

AT 1: Since the F-4's have obviously been sighted, an excellent opportunity exists to bleed down the bogey's energy level. F_1 should "push"* the bogeys as hard as possible to force them to continue their break turn.

F_2 should go high to a "cover" position, using his performance to gain vertical separation from F_1. This position allows: (1) an immediate roll-in should either bogey reverse after F_1 when they force him to overshoot, or (2) force the bogeys to "drive" up to engage F_2 after a long break turn, giving F_1 time to break off and reverse.

TECHNIQUES

AT 1: F_1 uses lead or pure pursuit to close on inside bogey, forcing B_1 into a maximum-rate turn. F_1 must go to lag pursuit (relax G) at the last moments to preserve angle off and nose-to-tail separation from B_1, as B_1 can, and does, force an overshoot.

* Refer to lead/pure/lag pursuit discussion in Fighter Versus Fighter portion of this section.

CONFIDENTIAL

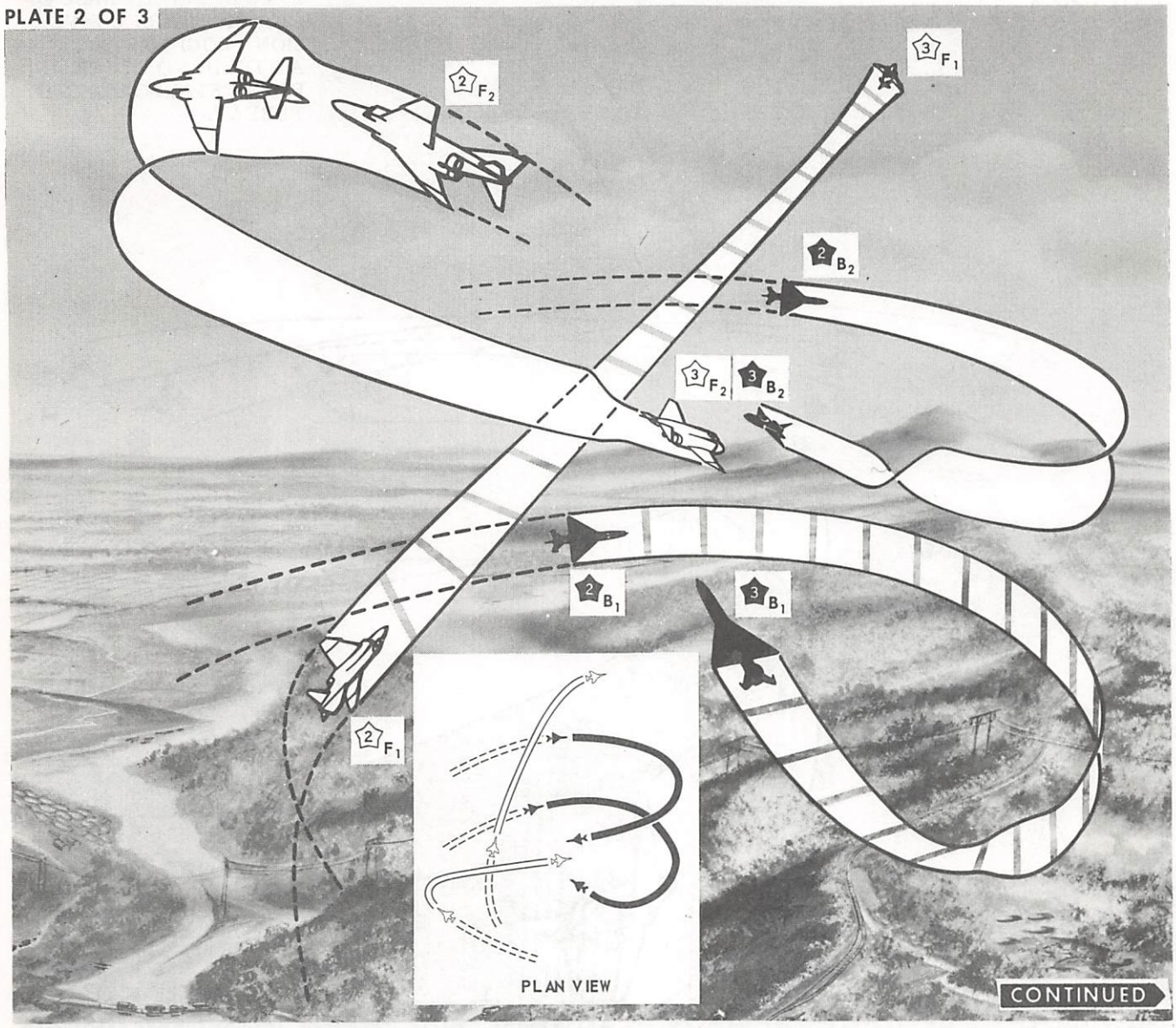
FDB-1T-(35-4)

Figure 1-32 (C) (Sheet 4 of 6)

LOOSE DEUCE OFFENSIVE TACTICS

SITUATION II
-Continued-

PLATE 2 OF 3



TACTICAL CONSIDERATIONS

AT (2): F_2's covering position prevents either bogey from reversing onto F_1 as he overshoots with nose-to-tail separation. F_2 should immediately roll in on the outside bogey (B_2) to keep the pressure on the opponents. F_1's reversal after the pitch-off will put him in position to attack again.

TECHNIQUES

AT (2): F_1 should continue his flight path to also press the outside bogey (B_2). F_1's RIO can watch B_1's actions after the first overshoot occurs. After pressing B_2, F_1 should convert his energy to vertical separation and reverse starboard back into the fight.

F_2 now rolls in to meet B_2 head-on. B_1 cannot turn tightly enough to pose a threat to F_2 as he passes.

F_2 should set up a port-to-port pass with a little lateral separation to commit B_2 port (away from B_1, which effectively throws B_1 out astern of the fight).

CONFIDENTIAL

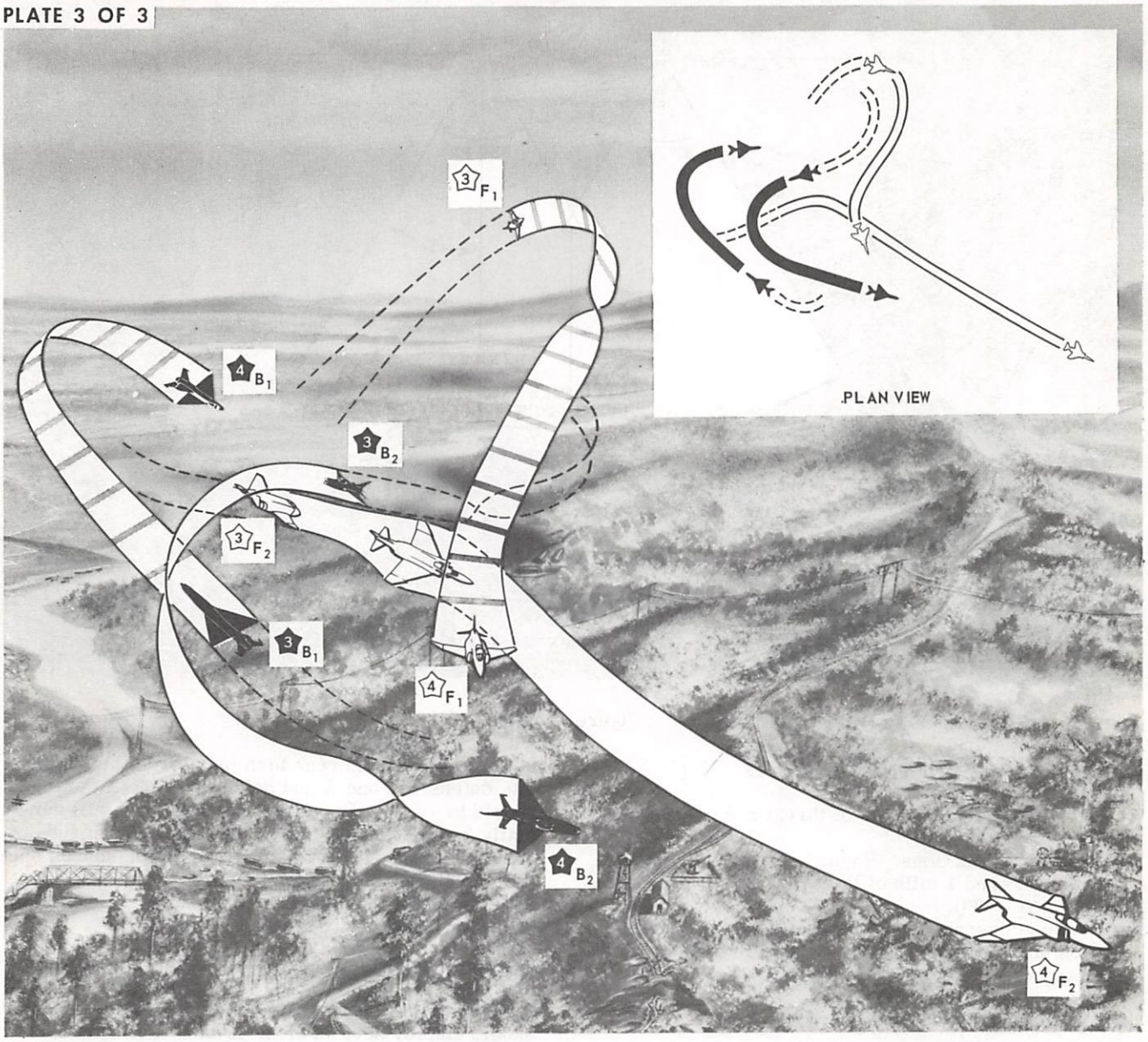
FDB-1T-(35-5)

Figure 1-32 (C) (Sheet 5 of 6)

LOOSE DEUCE OFFENSIVE TACTICS

SITUATION II
-Continued-

PLATE 3 OF 3



TACTICAL CONSIDERATIONS

AT (3): By deciding which way to commit B_2 to turn, F_2 is effectively controlling the progress of the fight. B_2's port turn will split the bogey section and destroy their mutual support. This is a major step that will provide a more rapid kill opportunity and keep the fighter section safe from immediate threat by the "free" bogey.

TECHNIQUES

AT (3): After the head-on pass, F_2 should turn hard starboard, kick the bogey across his tail to regain sight, and then extend. On the extension, once outside the bogey's weapon envelope, F_2 should arc (that's right arc) as much as possible. Every degree of turn by F_2 is a degree of turn that F_1 will not have to turn as he is in for the shot. This will result in a more rapid kill. F_1 will be in from B_2's blind belly side immediately after B_2's nose comes to bear on F_2 and he reverses his direction of turn.

CONFIDENTIAL

FDB-1T-(35-6)

Figure 1-32 (C) (Sheet 6 of 6)

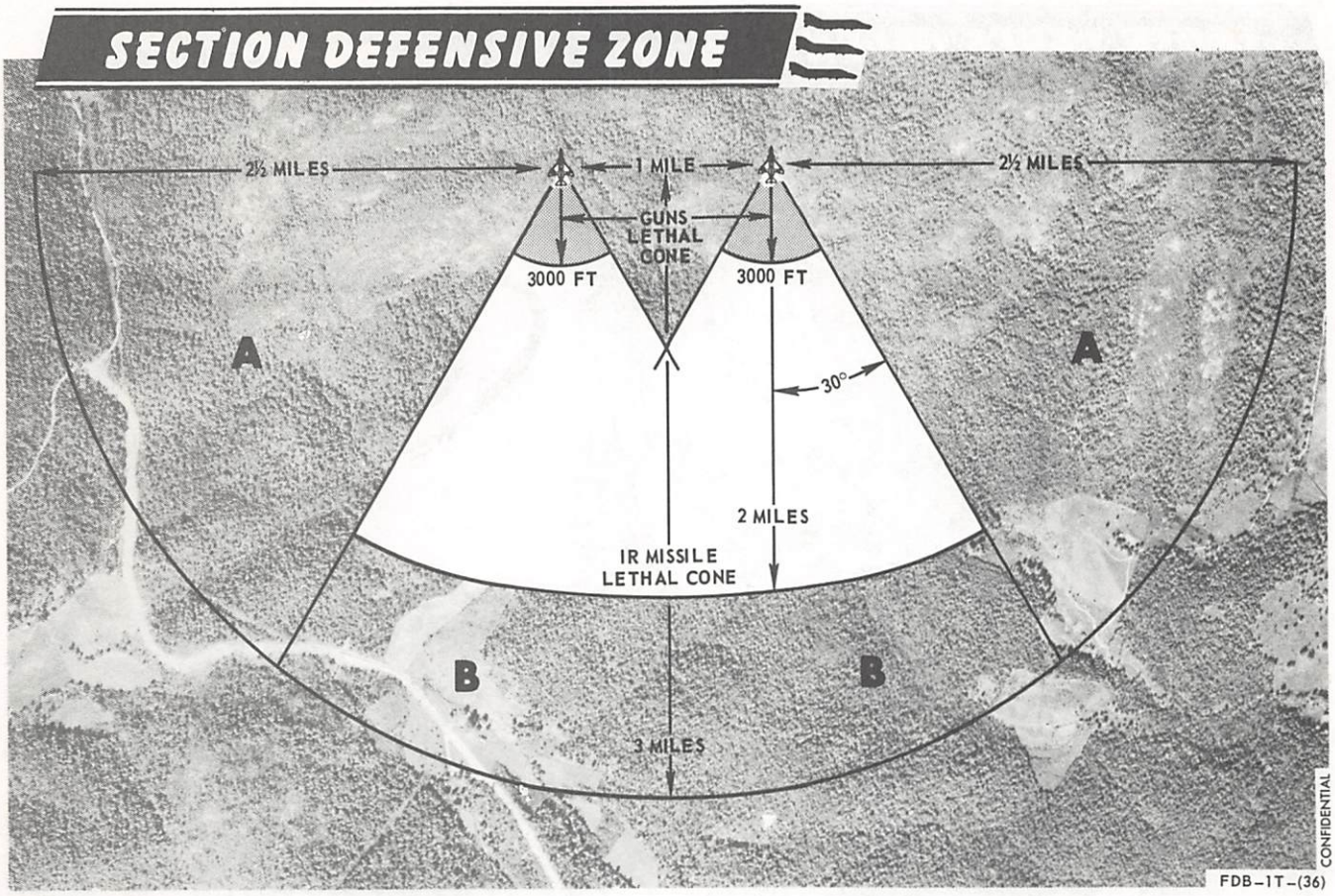


Figure 1-33 (C)

(U) DEFENSIVE ZONE ENGAGEMENTS

(C) Two general categories of threat are present:

a. Extreme situations. Enemy aircraft are detected within 30° and 1 mile of the tail. This is the lethal cone (figure 1-33).

b. Enemy aircraft detected aft of the beam within 3 miles and closing but outside the lethal cone. This is defensive zone A or B (figure 1-33).

(U) Lethal Cone (IR Missile Threat)

(C) When a bogey is detected in the IR lethal cone but not in gun range, an ATOLL break into the bogey must be initiated to sufficiently warp the IR envelope. From that time on, a hard turn will increase the bogey's angle-off and force him into defensive zone A, and defensive zone A tactics should then be employed.

WARNING

Do not use afterburner until the lethal cone is warped and rotated away from the bogey.

(U) Lethal Cone (Gun Threat)

(C) When a bogey is detected in the guns lethal cone, a break turn must be initiated. If the bogey has not placed himself in an ideal position or a tactical error is committed, the break turn may force the bogey into defensive zone A and defensive zone A tactics should be employed. However, the bogey will normally be able to maintain his position. Even subsonic/transonic fighters cannot easily be shaken once they reach the guns lethal envelope. The only adequate prevention is speed combined with lookout doctrine that prevents "deep six" attack.

(C) The fighter that is threatened must employ last ditch maneuvers discussed in single aircraft tactics. If his teammate is not immediately threatened he should employ section close combat tactics to force the bogey to break off the attack.

(U) Defensive Zone A Tactics

(C) In this region the fighters must accelerate, split to provide two threats, and achieve a high angle overshoot on the engaged F-4. The free F-4 should split as much as is feasible and press to support the engaged F-4. Typical UHF call: SNAKE BURNER, COME HARD RIGHT, TWO SPLIT HIGH, BOGEYS RIGHT 2 O'CLOCK, LEVEL 2 MILES. Two situations which can develop are presented in figure 1-34. NEW

(U) Defensive Zone B Tactics

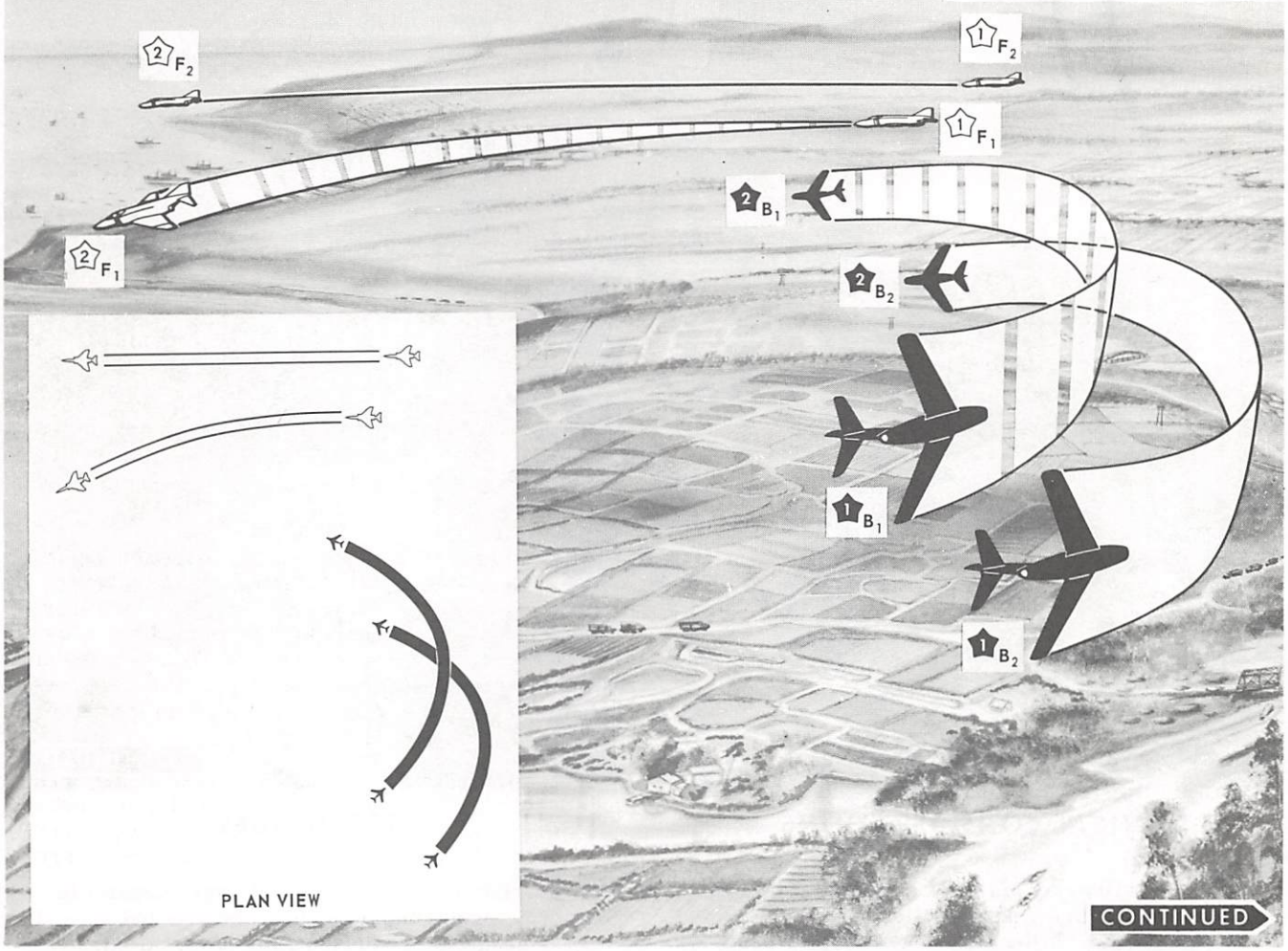
(C) If bogeys are detected in zone B, a section hard turn with the inside F-4 lagging to the outside of the turn will place the bogeys in defensive zone A. Zone A tactics then apply.

LOOSE DEUCE DEFENSIVE TACTICS

PLATE 1 OF 3

SITUATION I:

F-4'S DISCOVER MIG-17'S AT THEIR 8 O'CLOCK COMPLETING A BEAM GCI INTERCEPT. SINCE A TURN INTO THE BOGEY WILL NOT INCREASE ANGLE OFF, F-4'S ELECT TO EXTEND STRAIGHT AHEAD USING THEIR PERFORMANCE ADVANTAGE AGAINST A MACH-LIMITED ADVERSARY.



TACTICAL CONSIDERATIONS

AT (1): Fighters must create separation between themselves and the bogeys to allow room for a subsequent reversal and head-on pass. (Turning a defensive situation into a neutral situation). In addition, fighters must separate slightly between themselves to force the bogeys to engage only one fighter.

AT (2): Fighters have achieved sufficient separation from the bogeys to allow F_1 to reverse into them using a vertical pitch back.

TECHNIQUES

AT (1): Full afterburner is selected and separation airspeed is attained using optimum acceleration techniques. F_1 drops his left wing and turns slightly in order to keep the bogeys in sight. F_2 can keep the entire engagement in sight by just unloading straight ahead. As a result, the fighters have achieved a split, thereby forcing the bogeys to choose between them.

CONFIDENTIAL

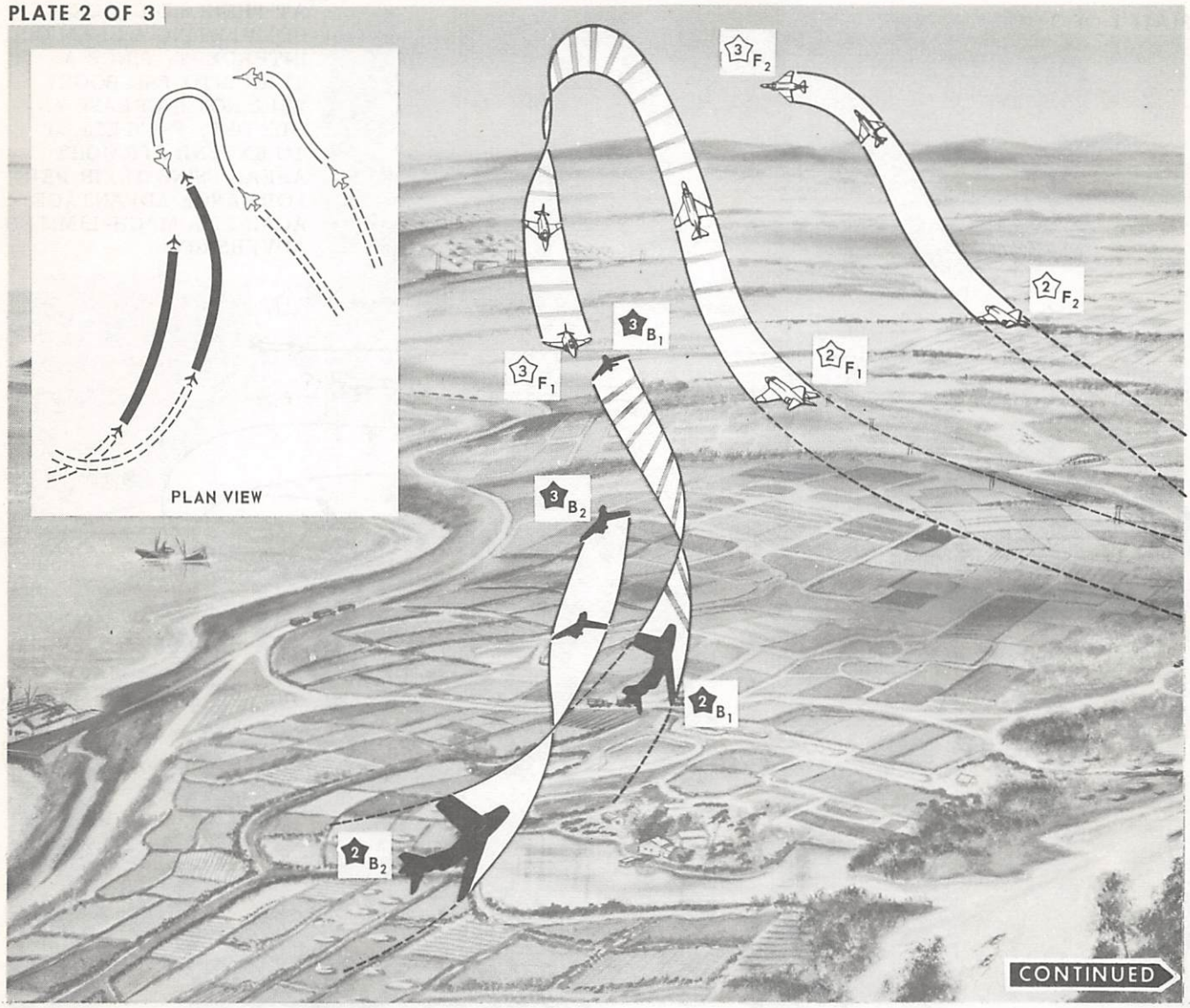
FDB-1T-(37-1)

Figure 1-34 (C) (Sheet 1 of 7)

LOOSE DEUCE DEFENSIVE TACTICS

SITUATION I
-Continued-

PLATE 2 OF 3



TACTICAL CONSIDERATIONS

AT (2): F_2 will delay his reversal several seconds to place himself in a cover position when F_1 achieves the head-on pass. If the first bogey (B_1) reverses on F_1, F_2 can roll in for a quick and easy kill. Do not expect B_1 to take the bait as he can see both fighters in his windscreen at the head-on pass.

AT (3): F_1 should expect to meet both bogeys head-on. After F_1 passes B_2, the bogeys are essentially between the two fighters. If either elects to engage F_1, the bogeys will split 180° in heading and the opportunity exists to attack that bogey. If both bogeys elect to continue straight ahead after F_2, they are operating as a single unit and F_1 as Free Fighter can reverse and position for an attack.

TECHNIQUES

AT (2): Having attained the necessary separation, F_1 performs an oblique loop to reverse and meet the bogeys head-on. By delaying his reversal slightly and, since he is on the outside of the port pitch back, F_2 maneuvers his aircraft to a high cover position at the same time F_1 is meeting the first bogey head-on. F_1 must pass the bogeys port-to-port, since F_2 would be in an ideal position to attack for a shot should one or both bogeys turn port after F_1.

CONFIDENTIAL

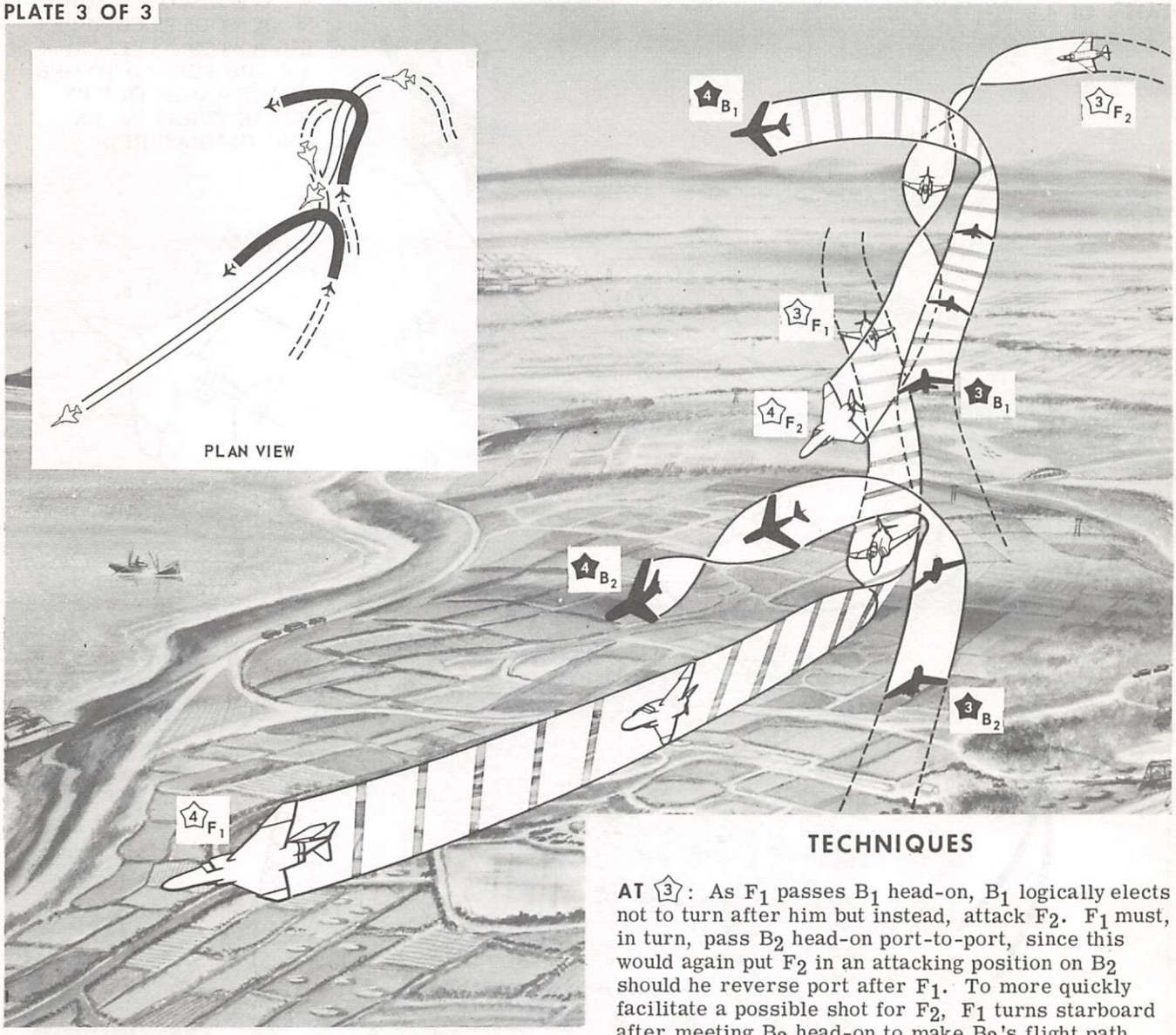
FDB-1T-(37-2)

Figure 1-34 (C) (Sheet 2 of 7)

LOOSE DEUCE DEFENSIVE TACTICS

SITUATION I
-Continued-

PLATE 3 OF 3



TACTICAL CONSIDERATIONS

AT 3: F_2 should transmit bogey's actions from his position as coverman. His delayed reversal now has the effect that if the bogeys do not switch back after F_1, they will be forced to "drive" to get to F_2's position, giving F_1 ample time to reverse. Should the bogeys elect this option, F_2 should delay his turn as long as possible prior to meeting the bogeys head-on. After the head-on pass, F_2 should then turn away from F_1. In the illustrated situation, B_2 reverses after F_1 after their port-to-port pass. F_2 must negate the threat of the lead bogey to give himself time to maneuver for a kill. The head-on pass with minimum lateral separation gives F_2 maximum maneuvering time by forcing B_1 into a 180° reversal.

TECHNIQUES

AT 3: As F_1 passes B_1 head-on, B_1 logically elects not to turn after him but instead, attack F_2. F_1 must, in turn, pass B_2 head-on port-to-port, since this would again put F_2 in an attacking position on B_2 should he reverse port after F_1. To more quickly facilitate a possible shot for F_2, F_1 turns starboard after meeting B_2 head-on to make B_2's flight path more predictable. F_1's starboard turn kicks B_2 across his tail, allowing the aircrew to regain sight while extending. This starboard turn also has the effect of stopping B_2's turn when B_2 is pointed directly away from F_2, offering an easy opportunity for a shot at a low-G target. Meanwhile, F_2 must maneuver his aircraft to pass head-on with minimum lateral separation to neutralize B_1 and then immediately turn starboard for a shot on B_2. F_2's port-to-port pass with B_1 forces B_1 to reverse port. This allows F_2's RIO to reacquire sight as he kicks B_1 across his tail while turning starboard for a shot. As the kill is made on B_2, the section is in position to reverse hard starboard to engage B_1.

CONFIDENTIAL
FDB-1T-(37-3)

Figure 1-34 (C) (Sheet 3 of 7)

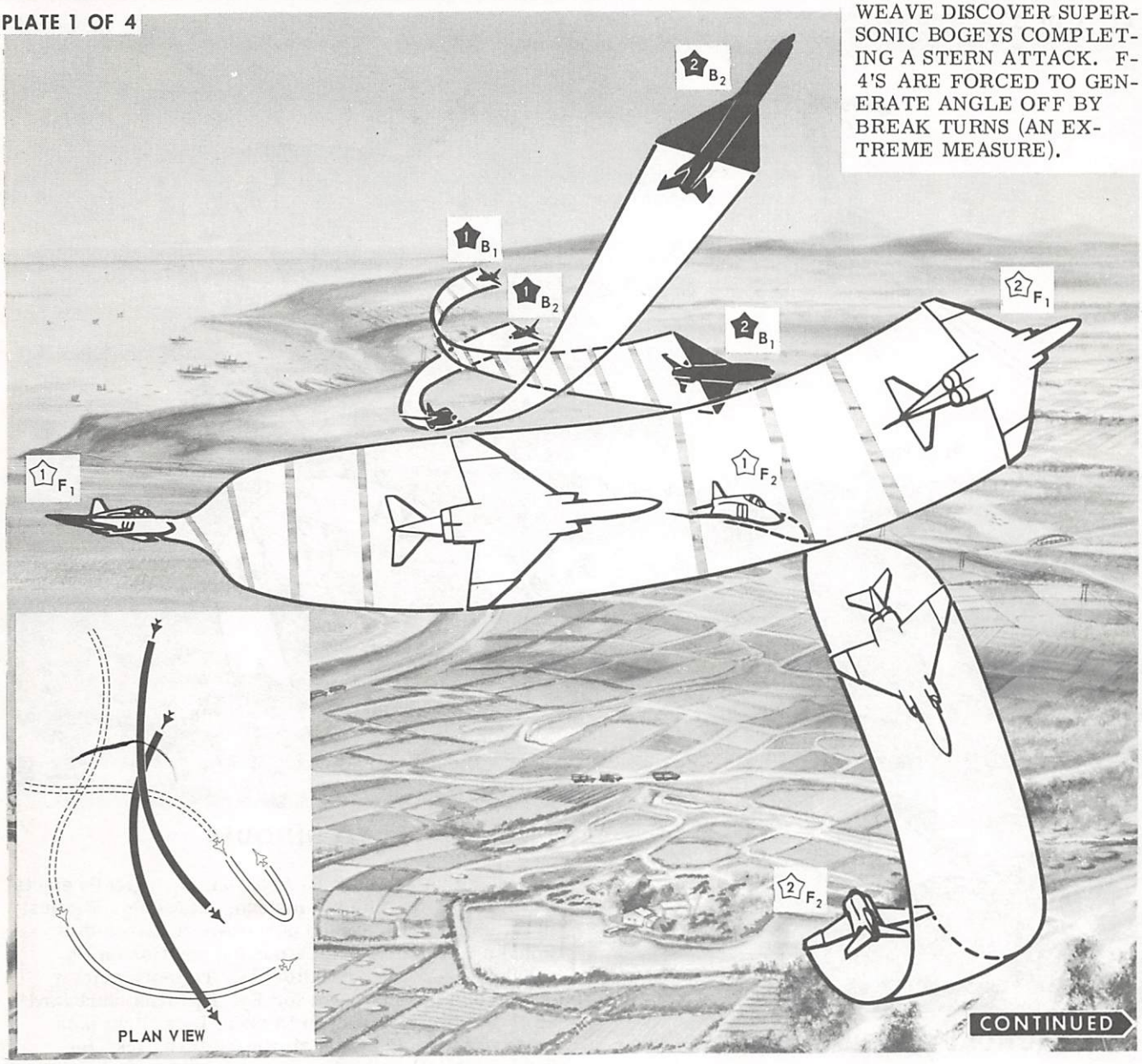
[redacted]

LOOSE DEUCE DEFENSIVE TACTICS

PLATE 1 OF 4

SITUATION II:

F-4'S IN A DEFENSIVE WEAVE DISCOVER SUPERSONIC BOGEYS COMPLETING A STERN ATTACK. F-4'S ARE FORCED TO GENERATE ANGLE OFF BY BREAK TURNS (AN EXTREME MEASURE).



CONTINUED

TACTICAL CONSIDERATIONS

AT (1): F-4's must break in different planes of turn to attempt to force the bogeys to attack only one fighter. Inside fighter (F_2) breaks hard down and outside fighter (F_1) breaks approximately level. Bogeys commit to the (logical) outside fighter. Bogeys are effective in continuing to press F_1, even after B_2 pitched off high due to high angle off/closure rate.

AT (2): Fighters have achieved the split. Bogeys are committed to F_1. F_2 must now start positioning to support F_1. F_1 must regain his energy and continue to keep angle off. Bogeys still have a definite advantage.

TECHNIQUES

AT (1): The depicted situation necessitates immediate defensive maneuvering by the fighters. F_1 breaks port and selects full afterburner in an attempt to force the immediate threat to overshoot. F_2 starts a port roll to a nose-low oblique reversal to gain vertical separation between the fighters and, at the same time, put his aircraft in a low cover position should either bogey present a shot opportunity while engaging F_1. B_2, in an overshooting situation, pitches off high. B_1 continues to press F_1 forcing him to continue his hard port turn.

FDB-1T-(37-4) CONFIDENTIAL

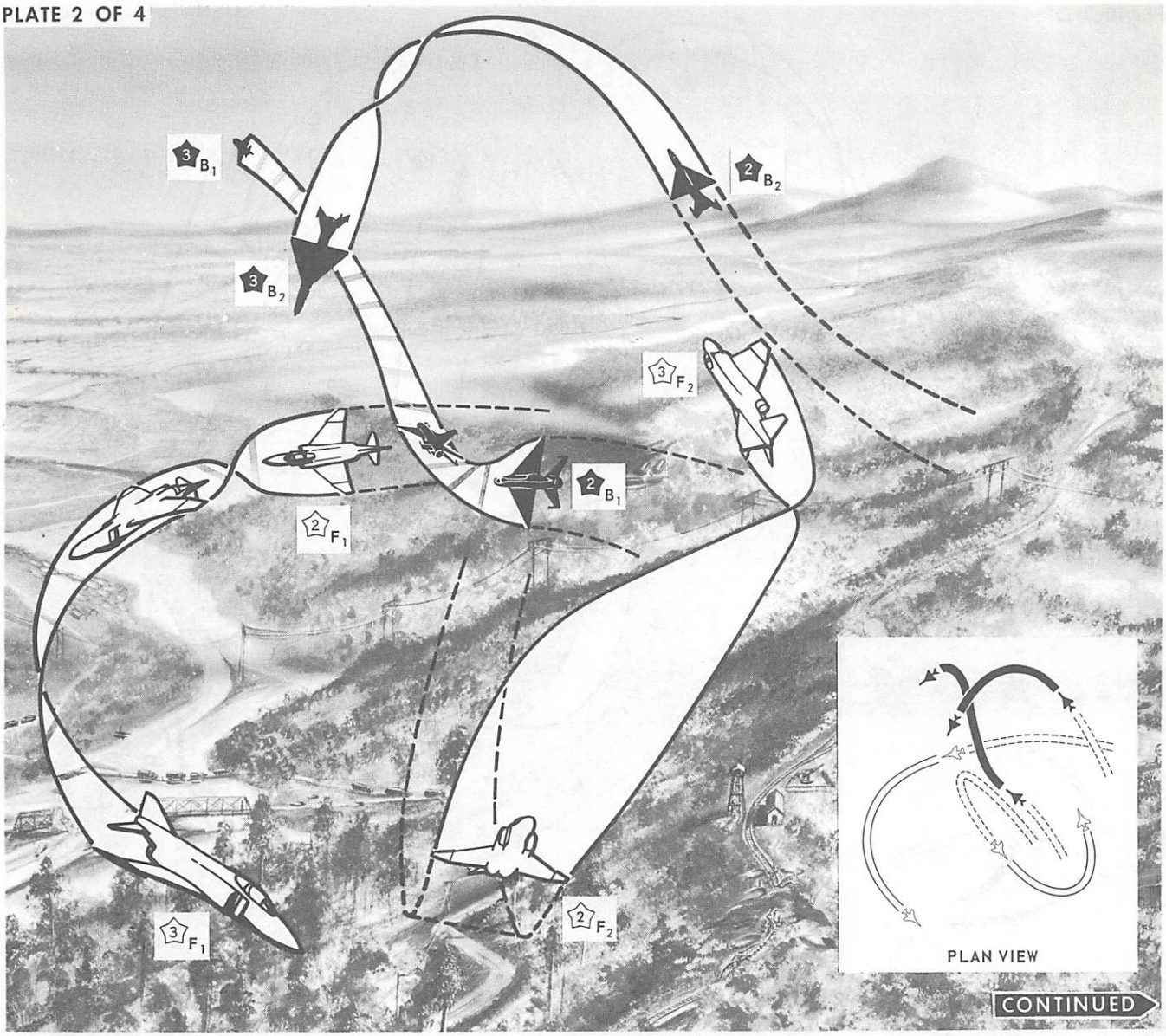
Figure 1-34 (C) (Sheet 4 of 7)

[redacted]

LOOSE DEUCE DEFENSIVE TACTICS

SITUATION II
-Continued-

PLATE 2 OF 4



TACTICAL CONSIDERATIONS

AT (2): F_1 has forced the second bogey to overshoot. F_1 must regain his energy and turns hard down. B_2 is reversing back to continue his attack on F_1. B_1 will pitch off now to cover B_2 in his second attack on F_1. The bogeys still have an energy and altitude advantage. The fighters must keep the fight tight and turning. F_2 should get outside this tight "eggshell" to have room to maneuver. The fighters are still at a disadvantage because F_1 is being forced to turn towards F_2, thereby keeping F_2 out in front of the fight.

AT (3): F_2, by operating in a plane of turn perpendicular to the fight, now starts to achieve an angle advantage over B_1 and B_2. Bogeys are still in support of one another, but are almost completely disregarding F_2. F_1 now starts back up with energy to continue his defense against attacking B_2.

TECHNIQUES

AT (2): F_1 is able to force B_1 to also overshoot and performs a classic counter to B_1's nose-high yo-yo maneuver. This allows F_1 to regain airspeed dissipated in the break turn. As B_1 pitches off high B_2 is back in on F_1 who has gained enough airspeed to begin to pull his nose back up into B_2. F_2, meanwhile, has bottomed out and is now getting his nose back towards the fight.

FDB-1T-(37-5)

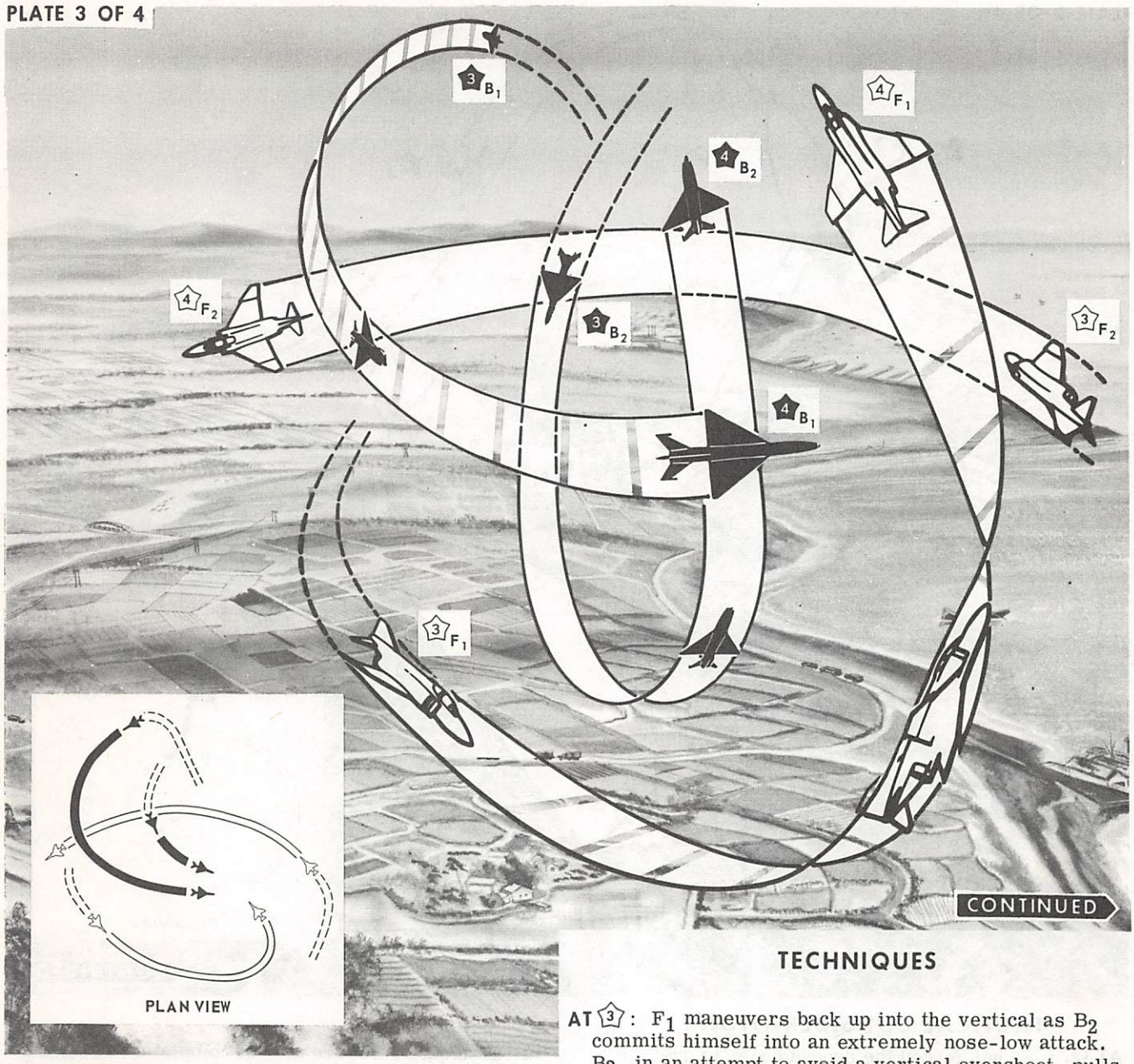
CONFIDENTIAL

Figure 1-34 (C) (Sheet 5 of 7)

LOOSE DEUCE DEFENSIVE TACTICS

SITUATION II
-Continued-

PLATE 3 OF 4



TACTICAL CONSIDERATIONS

AT 3 : B_1 now starts losing his support of B_2 and appears to arc in the level plane as B_2 dives and pulls up with F_1.

AT 4 : Since B_2 has an energy advantage, F_1 should not accept entry into a vertical rolling scissors. F_1 should force B_2 through the pure vertical and then continue turning into B_1. F_2 is now outside the "egg-shell" of the fight and commences a reversal in approximately the level plane while F_1 continues to operate in the vertical plane as described.

TECHNIQUES

AT 3 : F_1 maneuvers back up into the vertical as B_2 commits himself into an extremely nose-low attack. B_2, in an attempt to avoid a vertical overshoot, pulls outside and continues up into the vertical into what appears to be a vertical scissors with F_1. B_1 is, at this time, in an advantageous cover position for B_2, but chooses to do a shallow oblique reversal low and to the outside of the engagement. As F_2 starts back into the vertical, he realizes that he is not going to gain any advantage, because he will be too tight on the fight. Therefore, in anticipation of F_1 disengaging from the possible vertical scissors, F_2 extends slightly from the fight to gain sufficient maneuvering room and be in position for a shot.

CONFIDENTIAL

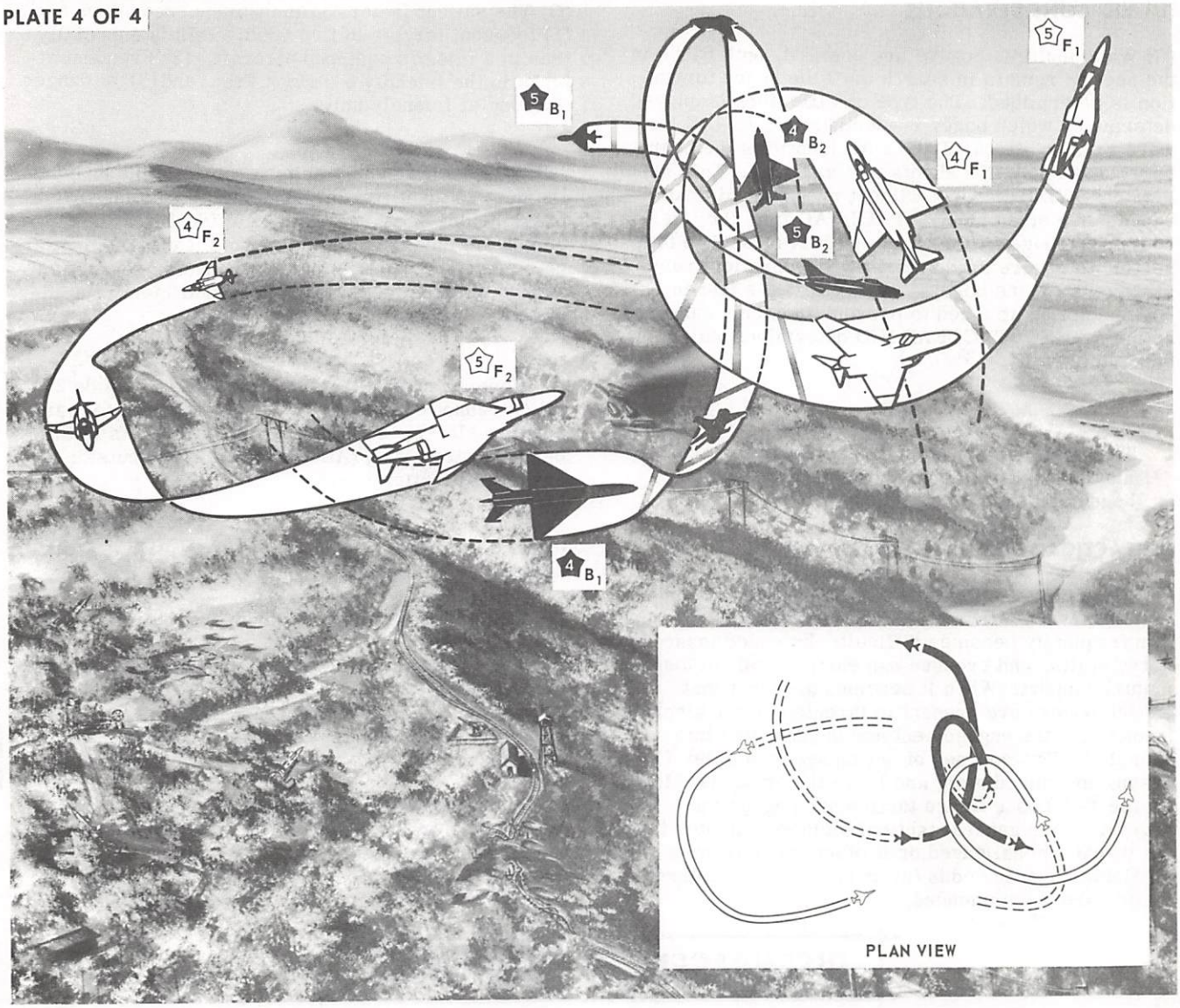
FDB-1T-(37-6)

Figure 1-34 (C) (Sheet 6 of 7)

LOOSE DEUCE DEFENSIVE TACTICS

SITUATION II
-Continued-

PLATE 4 OF 4



TACTICAL CONSIDERATIONS

Throughout the engagement, there has been little opportunity for F_1 to control his flight path. He has continually been under pressure to maintain angle off from the attacking bogeys. He has, however, optimized his energy conservation and turn performance by using the vertical extensively. F_2 has slowly gained maneuvering room and after (4), is able to reverse and position for a shot. B_1 continues ineffectively in the level plane. Should this engagement not terminate in a kill on B_2 at (5), F_1 would have to continue turning vertically and to the left with B_2 in order to keep B_1 ineffective.

TECHNIQUES

AT (4): As F_1 starts to lower his nose to extend from this position, B2 is forced higher because of his excess energy. B_2 loses some of his advantage as he tries to bring his nose back around and onto F_1 again. F_1 has attained sufficient separation airspeed and maneuvers to drag B_2 in a flight direction that coincides with F_2, who is in an immediate position for a kill. Meanwhile, B_1 realizes he has lost his cover position on B_2 and in an attempt to regain this position, circumscribes the engagement but finds himself ineffective as F_1 drags the fight away from him. Having achieved a kill on B_2, the fighters must now reverse back into B_1 to attempt to engage and destroy him.

CONFIDENTIAL

FDB-1T-(37-7)

Figure 1-34 (C) (Sheet 7 of 7)

ENGAGING MULTIPLE BOGEYS

(U) VID CONSIDERATIONS

(C) When multiple bogeys are engaged, both RIO's in the section remain in search until the bogey formation is determined. The type of VID attack employed determines which bogey is identified first. In a forward quarter attack, TACLEAD identifies the near bogey and TACWING shoots the far bogey. This allows TACWING to shoot without pressing minimum range. In a stern attack, TACLEAD runs the intercept on the bogey whose flight path is closest to the section to ensure adequate lateral separation from all bogeys. If the bogeys are in trail, the trailing bogey must be attacked to prevent an enemy sandwich on the section. TACLEAD RIO determines which bogey to identify.

Note

The possibility of other friendlies in the area may preclude the opportunity to eyeball one bogey and shoot another.

(U) TACTICAL CONSIDERATIONS

(C) After the initial maneuvers of an encounter involving several aircraft, control of the tactical situation frequently becomes difficult. Extended maneuvers, splits, and crosses can easily result in loss of mutual support. When it becomes apparent that enough bogeys are present to threaten either aircraft frequently, the engagement has degenerated into a "hassle". Two courses of action are available: (1) Disengage immediately and leave the area. (2) Modify the F-4 Loose Deuce tactics and engage the bogeys. If the general tactical situation dictates that the threat be challenged or if other friendly units available make the odds favorable, then the following tactics are recommended:

(C) The salient factors in multiplane encounters are: (1) frequent targets to fire upon. This is especially true in a missile equipped aircraft. (2) Frequent attacks in the friendly 6 o'clock area, and (3) the danger of firing at friendly units.

(C) With other friendly units involved in the hassle, the need to identify a target prior to shooting will preclude any shots outside visual identification range, unless the tactical situation makes it clear which targets are enemy. Even then, the angular separation and/or differential in V_C must be sufficient to minimize the risk of destroying a friendly.

(C) Under normal circumstances, shots outside 2 miles cannot be attempted. This precludes forward quarter AIM-7E-2 shots and any other shots in the beam or stern area (AIM-9 and AIM-7E) outside visual identification range.

(C) The following items are good operational procedures in this type of encounter:

a. Maintain a high energy level; do not slow for a missile shot.
b. Work the section in the vertical plane as much as possible.
c. Do not jeopardize your teammate for a kill.
d. Boresight, PLM or VTAS, lockups are used almost exclusively to avoid locking on friendly targets.
e. When TACWING is attacked, he goes low pulling the bogey in front of TACLEAD. Defensive zone tactics are then necessary.
f. If both fighters lose sight of any of the engaged bogeys, the section should consider disengaging.

DISENGAGEMENT TECHNIQUES

(C) Bingo fuel state or a fight that has degenerated into a defensive situation may dictate disengagement. A bingo state must be established which will allow enough fuel to disengage, clear enemy territory, and fly a bingo profile back to the ship or nearest divert field. As the F-4's near bingo fuel an evaluation of the situation and opportunity for disengagement must be made. It is imperative that the F-4's retire together and maintain section integrity. At the same time they must be cognizant of the enemy's position to negate any threat. When the decision is made to disengage the call BUGOUT, BUGOUT must be transmitted on the UHF and acknowledged. Normally, the free fighter will have sight of the engaged fighter as well as the enemy and can dictate the best escape heading and maneuver. This does not relieve the engaged fighter from his responsibility to check his own 6 o'clock. The best method to retire is to create a high angle off with the enemy and then unload with the wing down as necessary to keep the enemy in sight and create nose-to-tail separation. A run-out and pitch back maneuver might be desirable to create maximum angle off; however, fuel may not permit this. If the enemy's energy level is low a high arcing turn toward the retiring heading may be employed. Care must be taken not to turn too tight and allow the enemy to rendezvous on the inside of the turn and reach a firing position. Refer to figure 1-13, Effects of Arcing. Once the F-4's are clear of the enemy they should establish a combat spread formation and continue to cover each other. The Bugout maneuver should be practiced at the conclusion of all ACM engagements.

DIVISION FORMATIONS

(U) GENERAL

(C) The purpose of a fighter formation is to provide mutual defensive lookout coverage (radar and visual) while establishing maximum offensive potential. Number of aircraft and relative position will be dictated by the logic of availability, nature of fighter assignment, and the enemy threat. Each formation will include tradeoffs tailored to fulfill the mission. The F-4 has an excellent weapon system, including a radar system with an extremely large forward field of view. The radar does not cover the fighters rear hemisphere; therefore, a formation which provides for visual 6 o'clock coverage when employed in a clear air mass environment must be established. The F-4 aircrews must define radar coverage responsibilities as well as visual lookout responsibilities. It is mandatory to position for rear hemisphere coverage, either visually or with radar. If radar only is used because of darkness or weather conditions, the aircraft in a flight must maneuver in a pattern to look at the 6 o'clock of other members in the flight. The pure radar coverage pattern requires continuous turning or race track type maneuvering. The resultant distance traveled decreases range, time on station, or engagement time. Clear air mass tactics should utilize radar forward coverage and visual rear hemisphere coverage. This will eliminate the need for enroute fighter reversals and increase range, time on station, or engagement time.

(C) PLANNING REQUIREMENTS

a. Enemy threat - A complete understanding of enemy anti-air order of battle, enemy aircraft capabilities (including weapons), and methods of employment is mandatory to successfully defend assigned areas, or to achieve the offensive and ultimate air superiority.

b. Friendly aircraft - Knowledge of the capabilities of strike aircraft to be escorted or defended enroute or in assigned strike areas is essential to assist in determining fighter escort altitude, speed, and time on station. A thorough knowledge of the fighter weapon system is also mandatory for proper employment.

c. Assigned missions - Each different assigned mission will pose a different problem which may dictate variations in formation geometry and/or methods of engagement. Assigned missions may include the following: NEW

(1) CAP
(2) Escort
(3) Intercept

(U) LOOSE DEUCE SQUARED

(C) The loose deuce squared formation (figure 1-35) offers the maximum lookout coverage when patrolling while maintaining maneuverability and control during the pre-engaged phase. When a visual sighting or radar contact is made, the division leader has the option of committing either one section of aircraft or the entire flight, depending on the assigned mission and threat. Thus, the formation gives the division leader the flexibility of committing aircraft in a manner that best neutralizes the enemy threat.

(U) Pre-engaged (Hunter)

(C) Loose deuce squared formation is optimized for clear air mass fighter maneuvering due to the ex-

LOOSE DEUCE SQUARED FORMATION

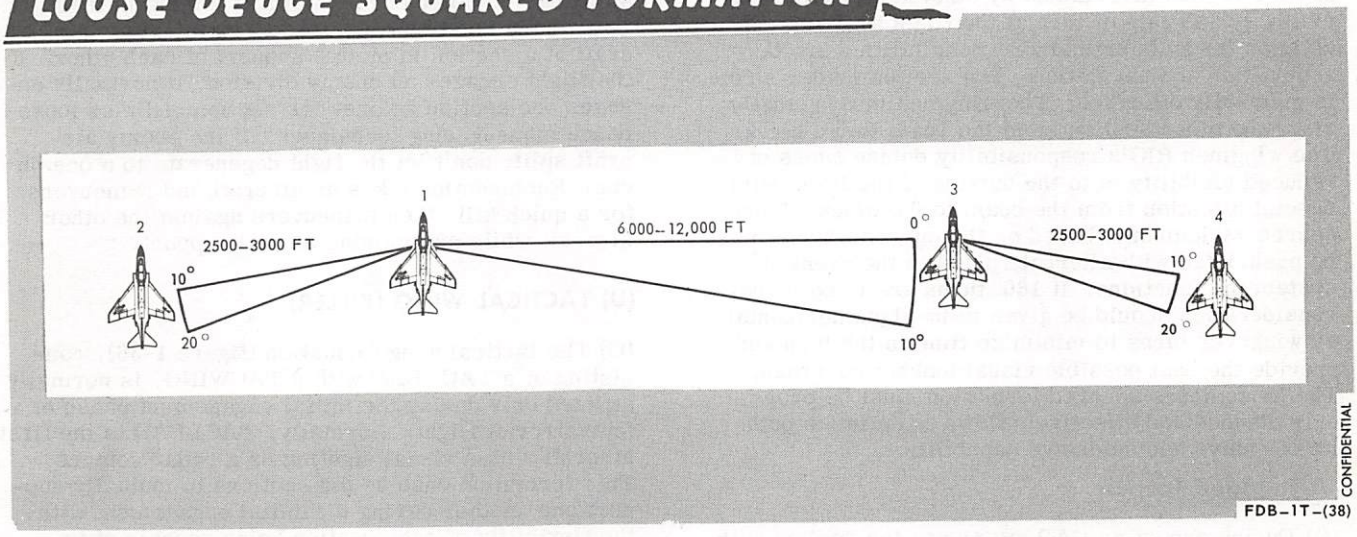


Figure 1-35 (C)

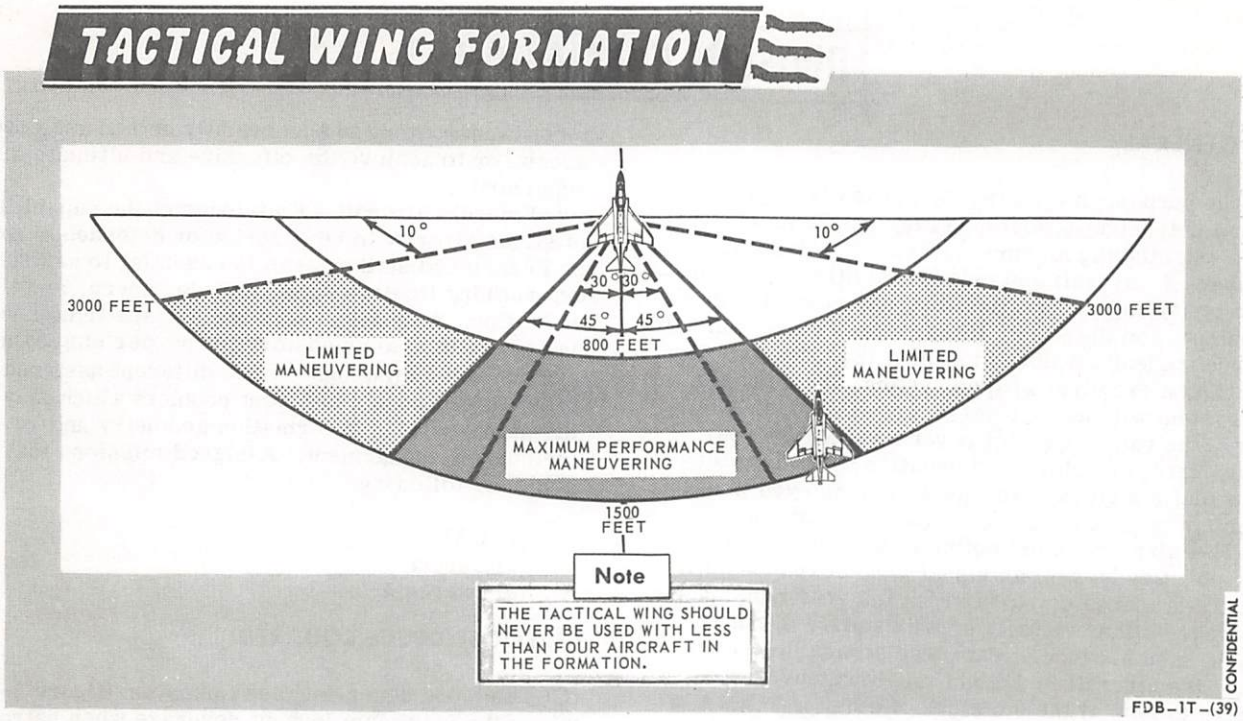


Figure 1-36 (C)

(C)
cellent radar and visual lookout coverage while maintaining maximum offensive potential. It employs the sections in a modified combat spread with the second section normally positioned 3000-6000 feet above and 6000-12,000 feet abeam the lead section (figure 1-35). This lateral separation should be determined primarily by an assessment of the enemy's best offensive weapon capability; i.e., if the enemy is capable of launching a missile at 9000 feet, lateral separation should be planned so number 2 and number 4 aircrews may clear the 6 o'clock to at least this range. Small check turns may be utilized to expand their rearward field of view but should be coordinated so both pilot and RIO concentrate on clearing the 6 o'clock. The magnitude of the lateral separation is also determined by other factors such as visibility and rate of turn at the flight altitude. The division leader's primary responsibilities are target acquisition and navigation. The section leader's role is primarily offensive. The wingmen must visually clear the other section from the beam to 6 o'clock. The wingmen RIO's responsibility during times of reduced visibility is to the outside of the flight with special attention from the beam to 6 o'clock. Radar search assignments based on the current threat must be prebriefed with alternate plans in the event of system malfunctions. If 180° turns are to be made, consideration should be given to in-place horizontal or wingover turns to minimize time in the turn and provide the best possible visual lookout coverage. The loose deuce squared formation must be properly planned and effectively flown to optimize both its offensive and defensive capabilities.

(U) Engaged Tactics

(C) During escort or CAP missions, the section with the first contact is normally detached to VID and engage the threat if only one or two aircraft are detected. Normal combat spread tactics apply. The other section remains as cover for the escorted aircraft or in CAP.

(C) In a clear air mass environment or a fighter sweep, the section with the first contact normally assumes the lead. If the contact is one aircraft or a section of aircraft, the wingmen move to a tactical wing or a close combat spread position as the formation maneuvers into the engaged phase. The section leaders employ the previously outlined offensive principles of loose deuce maneuvering, alternating as free and engaged sections. The F-4 sections split and fight independently any time it becomes advantageous, such as for a head-on VID, enemy aircraft splitting, or other enemy aircraft joining in the fight. Great care must be exercised to maintain the aircraft of a section in mutual support of each other. If the flight engages an enemy division, it normally engages one section against one section utilizing loose deuce maneuvering techniques. If the enemy aircraft split, don't let the fight degenerate to a one on one. Each section takes an aircraft and maneuvers for a quick kill, then maneuvers against the other aircraft while maintaining mutual support.

(U) TACTICAL WING (KILLER)

(C) The tactical wing formation (figure 1-36), consisting of a TACLEAD with a TACWING, is normally utilized only during the initial engagement phase of a four aircraft flight. Normally, TACLEAD is the first aircraft with a visual sighting or a radar contact. This formation enables the sections to mutually support one another during the initial engagement with the flexibility of each section being capable of immediately employing intra-section loose deuce tac-

(C)
tics. The sections should initiate intra-section loose deuce tactics whenever it becomes tactically feasible or advantageous. Up to the time of employing loose deuce tactics, any time the TACLEAD aircraft are not maneuvering at maximum performance the TACWING aircraft maneuver in the area of limited maneuvering. As TACLEAD's maneuvering becomes more violent, TACWING aircraft may be forced into the 60° - 90° cone of the maximum performance maneuvering area. The TACWING aircraft must maintain position and contribute to the overall effort of the division through good lookout doctrine and descriptive voice calls. Any time TACWING devotes all of his abilities to simply maintaining position, he is not a contributing member of the flight. Some tips to flying tactical wing are:

a. If the leader is in full afterburner, aircraft positioning is all you have to keep up.
b. Do not stay in-trail. Clearing the leader's 6 o'clock from in-trail is impossible.
c. Match the leader's bank and attitude immediately. Do not be forced out of phase.
d. Use aircraft positioning and/or power to maintain nose-tail separation with the leader. Do not end up between lead and the target.
e. Stay out of the high astern position. Any position that blanks out vision of the leader is a dangerous position.
f. Be agressive - The ability to stay in tactical wing with a maximum performance leader is 20% technical expertise and 80% true grit.

(U) DIVISION TACTICAL PRINCIPLES

(C) Four aircraft formation offensive considerations are:

a. TACLEAD - First section with a visual sighting or radar contact becomes the lead section. TACLEAD's responsibilities are:

(1) Maneuver to neutralize the enemy threat.
(2) Maneuver to destroy the enemy.

b. TACWING - Wingman provides support of TACLEAD's aircraft while maintaining the capability of commencing loose deuce tactics. TACWING's responsibilities are:

(1) Maintain position on TACLEAD through aggressive maneuvering.
(2) Provide visual coverage of TACLEAD.
(3) Assume TACLEAD if TACLEAD's weapons are expended or malfunctioning and/or maneuver to enhance the employment of loose deuce tactics.

c. Second section TACLEAD - Provide support of lead section. Second TACLEAD's responsibilities are:

(1) Provide visual coverage of first section while maintaining radar search of bogey area.
(2) Maneuver to provide offensive pressure utilizing engaged and free fighter tactics.
(3) When the first section makes a VID, ensure that aircraft in the second section are locked on the aircraft being VID, and that target assignment has been confirmed to be the bogey on their respective side.

COMBAT PERFORMANCE CHARTS

(U) AIRCRAFT MANEUVERABILITY

(U) Aircraft maneuverability can be defined as the ability to change the direction and/or magnitude of the velocity vector. While this definition accurately describes maneuverability, it provides little feel for the fighter pilot for acquiring optimum maneuverability. The following discussion and series of charts are designed to give a detailed insight into the mechanics of maneuvering.

(U) ENERGY MANEUVERABILITY

(U) Prior to participating in fighter versus fighter combat, the fighter pilot must know how to maneuver his aircraft to the greatest advantage. He must also know the capabilities and limitations of his opponent's aircraft. With an understanding of energy maneuverability, the fighter pilot can extract this vital information from simple diagrams. The information gained from these diagrams can be used to add precision to tactics already developed and, more importantly, to develop comparisons for use as a basis for designing tactics against potential opposing fighters.

(U) Effective tactics reflect the best way to gain a favorable position. The maneuvering necessary to gain this favorable position depends upon the interaction of armament, turn, altitude, airspeed, and acceleration. The type of armament will define the firing envelope, hence the relative position to be sought in order to effectively employ this armament. How to maneuver into the firing envelope is the prime problem in air-to-air combat.

(U) Assuming that a thorough knowledge is possessed of the F-4 armament envelope and that intelligence has provided enemy weapon system capability, this section will discuss the four factors of maneuverability; turn, altitude, airspeed, and acceleration.

(U) To gain a maneuvering advantage, energy must be managed more wisely by a given pilot than it is by his opponent. It follows, then, that tactical maneuverability is a function of energy, the amount of energy possessed, and how well that energy is managed in seeking a favorable position. For best maneuverability, this means that a fighter pilot should attempt to enter an engagement at a relatively high energy level.

(U) One criteria for comparing fighters is the ability to accelerate the direction of flight. Longitudinal acceleration (Nx) is derived primarily from excess thrust and is given by the expression: Thrust-Drag = NxW. Assuming maximum thrust and constant weight, the real variable is drag. Drag at zero lift (i.e., parasite drag and wave drag) is a function of Mach, altitude and external configuration. Induced drag (drag due to lift) is also a function of Mach and altitude. Further, it is also directly related to normal load factor. Thus, the pilot has certain control over the three factors which have the greatest effect on acceleration and climb performance. If the whole expression for longitudinal acceleration is given by

$Nx = \frac{T}{W} - \frac{Dp}{W} - \frac{Di}{W}$ the controls are apparent:

$\frac{T \text{ (thrust; pounds)}}{W \text{ (weight; pounds)}}$ - throttle

$\frac{Dp \text{ (parasite drag; pounds)}}{W \text{ (weight; pounds)}}$ - external configuration

$\frac{Di \text{ (induced drag; pounds)}}{W \text{ (weight; pounds)}}$ - load factor

(U) Multiplying the whole expression by velocity (feet per minute) provides rate of climb (Rc), which is equivalent to Ps or specific excess power as defined in Energy Maneuverability studies.

$$NxV = V\left(\frac{T}{W} - \frac{Dp}{W} - \frac{Di}{W}\right) = Rc$$

(U) The other criteria in comparing fighters is turn performance. The pilot is most interested in two aspects of turn performance: turn radius and turn rate. Both are functions of velocity and effective wing loading. Effective wing loading can also be expressed in terms of normal load factor (Nz).

$$\left(Nz = \frac{L}{W} = \frac{M^2 C_L}{W/S} \text{ x a function of altitude}\right)$$

Where: L = lift (pounds), W = weight (pounds), M = Mach, W/S = wing loading (pounds per square foot), C_L = coefficient of lift, and a function of altitude = 1481 times the ambient pressure ratio (P/P_o or ambient static pressure divided by standard sea level static pressure).

(U) Since maximum normal load factor is determined by either aerodynamic limits or structure limits, the V-N diagram is an effective tool for turn comparisons. The intersection of these two limits is often called simply, "the left hand corner" (figure 1-37).

(U) The left hand corner yields the maximum instantaneous turn capability of an airplane. Obviously, an airplane with a left hand corner displaced further to the left enjoys advantage in instantaneous turn performance. However, this gives no insight into the sustained turn picture. Sustained performance is derived from Energy Maneuverability plots. Generally, due to the large wing area, delta wing planforms enjoy a large advantage in instantaneous turn capability. However, due to the necessity of reflexing the wing to increase G, the total lift decays markedly as the turn is sustained.

(C) By analysis of these relationships, comparison of turn, climb, and acceleration capabilities between various airplanes is possible - before meeting in the air. However, these comparisons do not measure the man, nor do they provide specific tactics or techniques for fighting another airplane. They merely give the aircrew an indication of the areas where the fight should transpire. It remains for the pilot to maneuver his airplane into the areas where his advantages are maximum and those of his adversary are minimum of negated. With this comparison technique it becomes readily apparent that airplanes with marked differences in capability should not be fought the same way. A quick comparison of a MIG-17 versus an F-4 shows that turn capability is the MIG-17's strong suit. Therefore, a low G, high airspeed, and low altitude fight should be anticipated. As yet, the man cannot effectively be compared before the fight. Thus, continual practice is mandatory to quickly assess an opponent to realize what techniques will be effective in getting a kill as quickly as possible. All this requires prior planning and thought. To be effective, the fighter crew must always plan, plan, plan. On every flight, always know exactly where the sun is, where the clouds are, whether a tanker is airborne, the shortest route to friendly territory, etc.

(U) One point of caution should be noted about the energy maneuverability diagrams. Although the charts show that the F-4 is capable of 8.5G at low altitude, this is not permitted on combat configured F-4 carrying AIM-9 missiles. Any time AIM-9 missiles are loaded on stations 2 and 8, the maximum G permissible is 6.5G, and this is with the gross weight at 34,700 pounds or less. The charts in appendix A indicate that to load four AIM-9D missiles (usually desired for combat), the following items must be added to the weight of the basic aircraft:

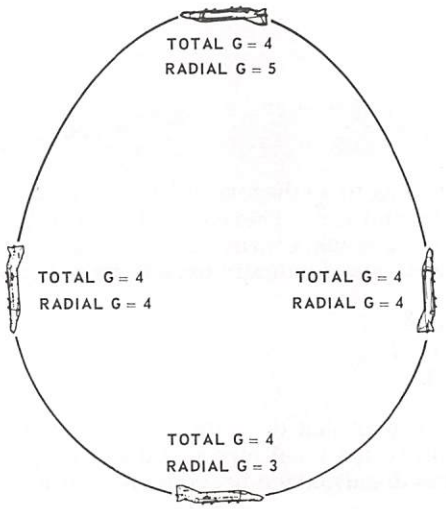
Two LAU-17/A launchers (150 lb. each)	300 lb.
Four LAU-17/A launchers (87 lb. each)	348 lb.
Four AIM-9D missiles (197 lb. each)	788 lb.
One AERO-27A rack	52 lb.
	1,488 lb.
Add four AIM-7E-2 missiles (427 lb. each)	1,708 lb.
	3,196 lb.
Plus basic F-4J weight	31,420 lb.
	34,616 lb.
Plus enough fuel to disengage and return to base; for example	4,000 lb.
	38,616 lb.

(U) The 38,616-pound aircraft weight is where disengagement occurs (assuming no missiles fired). This means that the pilot must fight the aircraft at this weight or heavier and that he must learn to fight and win with less than 5.75G. Remember, you play the game like you practice, and there is no appreciation for overstressed aircraft.

(U) TOTAL G VERSUS RADIAL G

a. Radial G is the G which actually turns the aircraft in the vertical and horizontal plane. Radial G does not represent the total G on the aircraft because it neglects the force of gravity. The rate of turn which an attacker needs to track a target may be expressed as radial G.

b. Total G includes radial G and the force of gravity; remember that the aircraft stalls on total G.

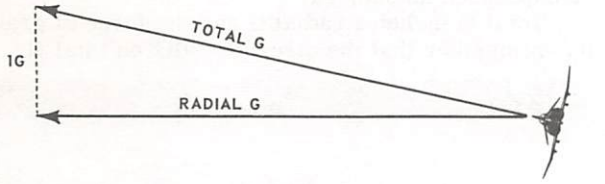


(U) During vertical maneuvers, the force of gravity aids turning performance when the aircraft lift vector is below the horizon and degrades turning performance when the lift vector is above the horizon. For the purpose of illustrating the effect of gravity on radial G during a vertical maneuver, assume that an aircraft maintains a constant true airspeed, a constant total (indicated) G, and a common turn radius center. An egg shaped envelope results from the effect of gravity.

(U) In actual flight the aircraft accelerates in dives and the egg shape of the vertical envelope is accentuated. However, higher sustained load factors are possible. Therefore, for maximum turn rate, maneuver so that gravity is favorably affecting the thrust vector and the turn.

(U) TOTAL G-RADIAL G RELATIONSHIP

a. Level or high side attack:



UNCLASSIFIED

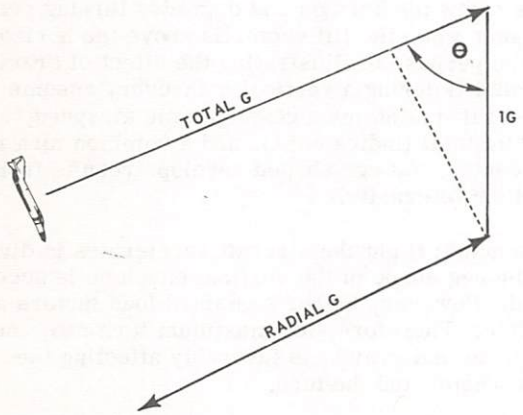
FDB-1T-(41)

(U) According to Pythagorean Theorem (total G)^2 = (1G)^2 + (radial G)^2. Therefore, if 3 radial G are necessary to track a target in a level pursuit curve, 3.16 total G would actually have to be pulled.

$Gt^2 = Gr^2 + 1$
$Gt^2 = 9 + 1$
$Gt = 3.16$

(U) It is evident that the difference between total G and radial G in a level turn is a disadvantage. However, this disadvantage becomes less at higher G values.

b. Turning with the lift vector above the horizon:



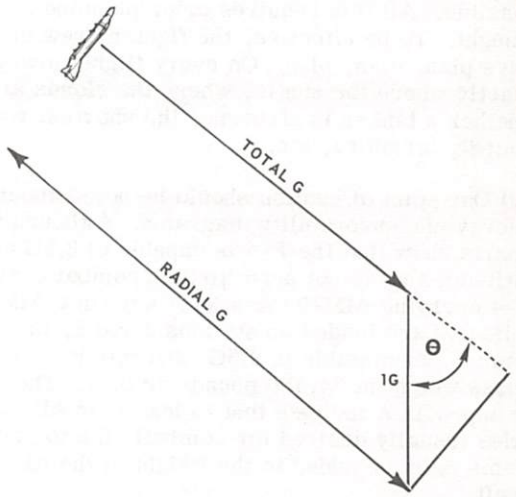
UNCLASSIFIED

FDB-1T-(42)

(U) The G relationship with the lift vector above the horizon may be expressed as: Gt - Gr + Cos θ. Therefore, if the rate of turn required to track is 3 radial G, the total G required when θ equals 30° will be:

Gt = Gr + Cos θ
Gt = 3 + .866
Gt = 3.866

c. Turning with the lift vector below the horizon provides a favorable G relationship.



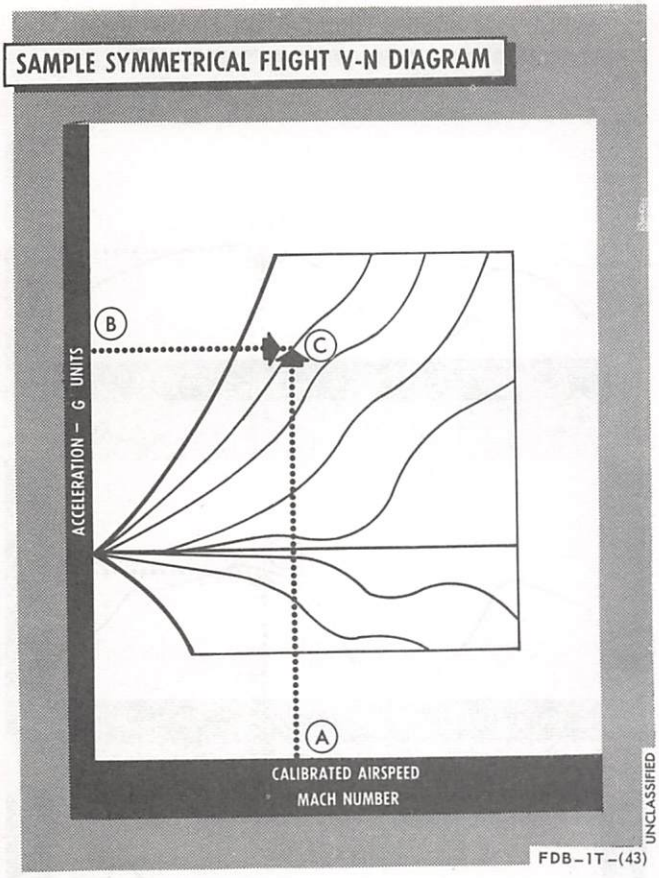
UNCLASSIFIED

FDB-1T-(42)

(U) This relationship may be expressed by the formula: Gt = Gr - Cos θ. Therefore, if 3 radial G are required to track a target and θ equals 30°, total G will be:

Gt = Gr - Cos θ
Gt = 3 - .866
Gt = 2.134

(U) It is obvious, therefore, that anytime the lift vector is oriented below the horizon both rate and radius of turn are optimized.



(U) SYMMETRICAL FLIGHT V-N DIAGRAMS

(U) The symmetrical flight V-N diagrams (figure 1-37) are graphical presentations of instantaneous performance in terms of load factor (G). Only two charts are provided but they may be considered to be linear between altitudes for all practical purposes, provided the interpolation is carried out for a constant Mach number. V-N diagrams provide no measure of sustained performance.

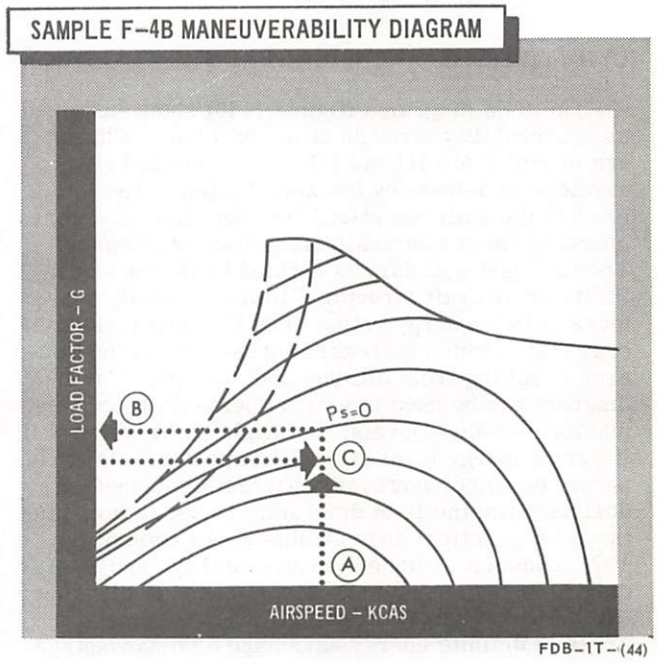
(U) Use

(U) To find the allowable maximum symmetrical performance capability, enter the chart with the calibrated airspeed or Mach number and proceed vertically to the stall boundary (positive or negative G) or the maximum allowable acceleration (upper and lower) as applicable. From these intersections, project horizontally to the left to read the positive and negative G obtainable in the case of the stall boundaries, or the upper and lower maximum allowable G for the selected gross weight. To find the angle of attack for a given condition of G and airspeed or Mach number, enter the appropriate chart with these parameters. Project horizontally to the right from the load factor and vertically upward from the airspeed or Mach number. At the intersection of these two projections, read the indicated angle of attack.

(U) Sample Problem

(U) Altitude: Sea level, gross weight: 37,500 pounds

A.	Speed	550 KCAS
B.	Load factor	5G
C.	Angle of attack	8.2 units



(U) MANEUVERABILITY DIAGRAMS

(U) Unlike the V-N diagrams, the maneuverability diagrams (figures 1-38 and 1-39) depict sustained maneuverability. These charts show specific power (P_S) contours within the limitations of the aircraft. Although P_S is expressed in terms of feet per second of climb or descent, the indicated specific excess energy may be converted to additional G or velocity. The P_S = 0 ft/sec line indicates a G-speed relationship where no excess power is available. A negative P_S value indicates that the aircraft must, in the case of a constant altitude chart, lose velocity or G, or both. This energy decay is depicted on the charts for 19 and 20 unit turns of 180° with initial velocities of 400 and 450 KCAS.

(U) Use

(U) To find the maximum sustainable performance enter the chart with calibrated airspeed and proceed vertically to the P_S=0 line or the structural limit. Then, proceed horizontally to find the maximum sustainable G. The intersection of any load factor and calibrated airspeed which falls within the envelopes indicates positive or negative P_S existing at that point.

NEW

(U) Sample Problem - F-4B/N

(U) Altitude: Sea level, gross weight: 37,500 pounds, maximum power.

A.	Speed	400 KCAS
B.	Maximum sustained load factor	5G
C.	Ps for a load factor of 1.0G @ 400 KCAS	500 FT/SEC

(U) H-M (HEIGHT-MACH) DIAGRAMS

(U) The H-M diagrams (figure 1-40) show sustained maneuverability throughout the envelope. Charts are provided for 1G and 5G. The sustained flight envelope is defined by the zero P_S line. The left limit is the stall boundary. The top limit is determined by the thrust available - drag relationship. The far right boundary is defined by thrust - drag limits or aircraft structural limits. The P_S contours reflect energy rates. The E_S lines reflect energy states which disregard thrust, and reflect energy resulting from altitude and velocity. The H-M diagram can be used to extract best climb profiles, maximum energy levels, and flight paths which will improve energy level in the least possible time. It should be noted, however, that tactics cannot be derived from the H-M diagram. To the fighter pilot the most practical and valuable application of the V-N, constant altitude maneuverability, and H-M diagrams is in performance comparisons with other aircraft. In comparing performance diagrams, areas of definite energy advantage or disadvantage can be determined and best operating flight regimes can be established.

(U) INSTANTANEOUS RADIUS OF TURN CHART

(U) This chart (figure 1-41) depicts instantaneous radius of turn from sea level to 30,000 feet, throughout the speed regime of the aircraft. No measure of sustained performance can be derived from this chart. The chart does point out:

a. Radius of turn at a given altitude does not change appreciably with an increase in airspeed, up to a point where structural limit G or optimum angle of attack is attained.

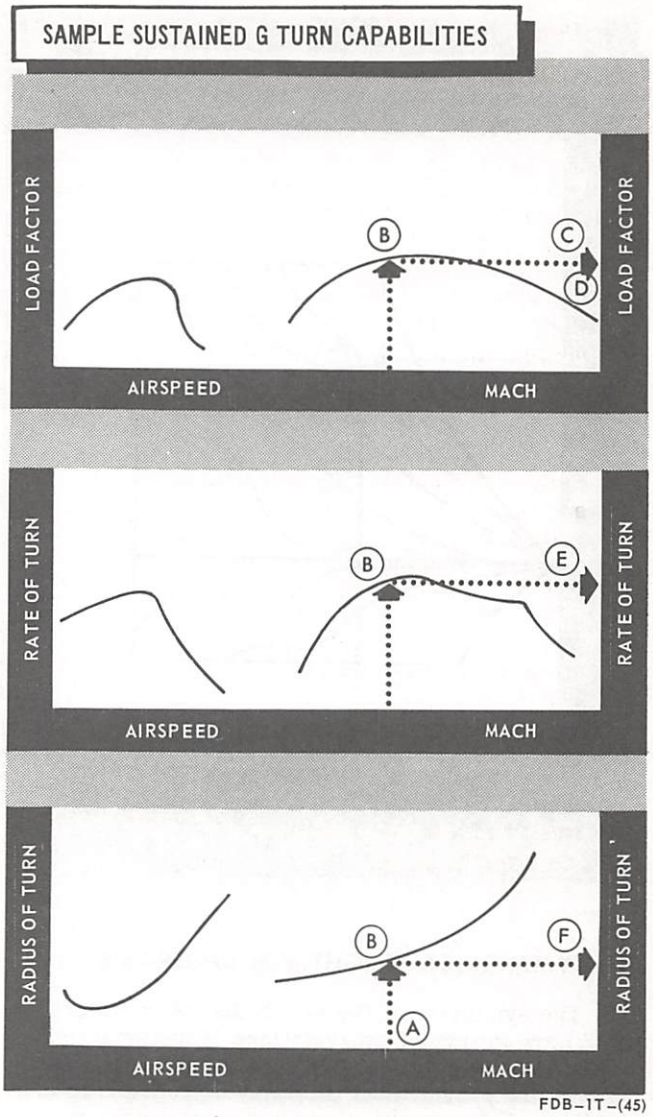
b. Instantaneous G available does not vary if airspeed remains constant.

c. Radius of turn increases radically if velocity is increased past the point where structural limit G or optimum angle of attack is reached.

(U) SUSTAINED G TURN CAPABILITIES

NEW

(U) The sustained G turn capabilities charts (figure 1-42) provide a direct readout of sustained rate and radius of turn for the F-4B/N and F-4J. These charts describe level turns. The load factor chart also provides the bank angle required to produce maximum sustained G.



FDB-1T-(45)

(U) Use

(U) Enter the chart with Mach or calibrated airspeed and proceed vertically to intersect the applicable altitude in each of the plots. From these intersections, proceed horizontally to the left or right and read load factor/bank angle, rate of turn in degrees per second, and radius of turn in nautical miles.

(U) Sample Problem - F-4B/N

NEW

(U) Configuration: (4) AIM-7E and (4) AIM-9D - Gross Weight: 37,500 pounds.

A.	Mach	0.8
B.	Altitude	20,000 FT.
C.	Bank angle	74°
D.	Sustained load factor	3.6G
E.	Rate of turn	7.5°/SEC.
F.	Radius of turn	1 NM

(U) HEADING REVERSAL CHARTS

NEW

(U) The heading reversal charts (figure 1-43), which apply to F-4B/N and F-4J, present a comparison of combat turns for different initial airspeeds and altitudes. The turns shown are split-S, wind-up (level), immelmann, and constant flight path angle turns. All turns represent 180° heading change. A three view pictorial profile of each turn indicates down range, cross range, and altitude gain or loss for each maneuver. On the opposite page a time history of bank angle, load factor, speed, and altitude change is presented. The position of the aircraft at the completion of a constant flight path angle turn is a nose up or down attitude equal to the constant flight path angle. Example:

In the -45° constant flight path angle turn initiated at 10,000 feet and 350 KCAS, the aircraft is rolled into a 135° bank (time starts at this point). The aircraft is pulled through this slicing maneuver for 3.5 seconds and then a top rudder roll to 85° of bank is initiated. The aircraft flight path is now 45° down, the bank angle is 85°, and the turn is continued until a 180° heading reversal is accomplished. An examination of the time histories reveals that altitude lost was approximately 4500 feet, end speed was 405 KCAS, maximum G attained was 6.2G, and the maneuver was completed in 10.6 seconds. At end time, the aircraft is still in a 45° descending attitude.

(U) The wind-up turn is a constant altitude heading reversal performed at maneuvering limit angle of attack. Airspeed and G are allowed to bleed off in order to maintain a constant altitude and angle of attack.

Example: In the wind-up turn initiated at 10,000 feet and 350 KCAS, the aircraft is rolled into a 76° bank (bank angle required for maximum sustained G) and pulled into a 20-unit angle-of-attack turn. Bank angle and angle of attack are held until a 180° heading reversal is accomplished. An examination of the time histories reveals that altitude loss is zero, end speed is 305 KCAS, maximum initial G is 4.7, and the maneuver is completed in 16.5 seconds. At end time the aircraft is still in a 73° bank.

Note

Aircraft configured with 4 AIM-9D and 4 AIM-7E missiles and with a gross weight of 37,500 pounds do not contain much fuel. This gross weight was selected because it allowed the maximum structural load factor to be depicted on the charts. It should be remembered that maneuvering performance varies inversely with a gross weight increase incurred by addition of a combat fuel package.

(U) SPLIT-S MANEUVER CHARTS

(U) Two series of charts and tables describe the split-S maneuver (figure 1-44). The first series describes a maneuver executed at 16 units angle of attack. The second series describes a maneuver executed at 20 units below 15,000 feet and 19 units above 15,000 feet. Each maneuver is described by a series of six charts and tables. The first table establishes the initial airspeed and power settings for each of the three situations. The Final Speed chart is entered at start-maneuver altitude, read horizontally to the proper line, and straight down to find the terminal airspeed at the completion of the maneuver. The Time To Turn chart and the Altitude Loss chart are read in the same manner. The Difference Attributed to Change In Power Setting table addresses maneuvers initiated at 350 and 450 KCAS. It shows that maximum power, under these conditions, increases energy and G available, and results in improved rate and radius of turn. The use of idle power until the aircraft is vertical and military power for the remainder of the maneuver results in a slower turn, more altitude lost, and a lower end airspeed. The F-4B/N and F-4J difference chart is self explanatory.

SYMMETRICAL FLIGHT V-N DIAGRAM

ALTITUDE SEA LEVEL

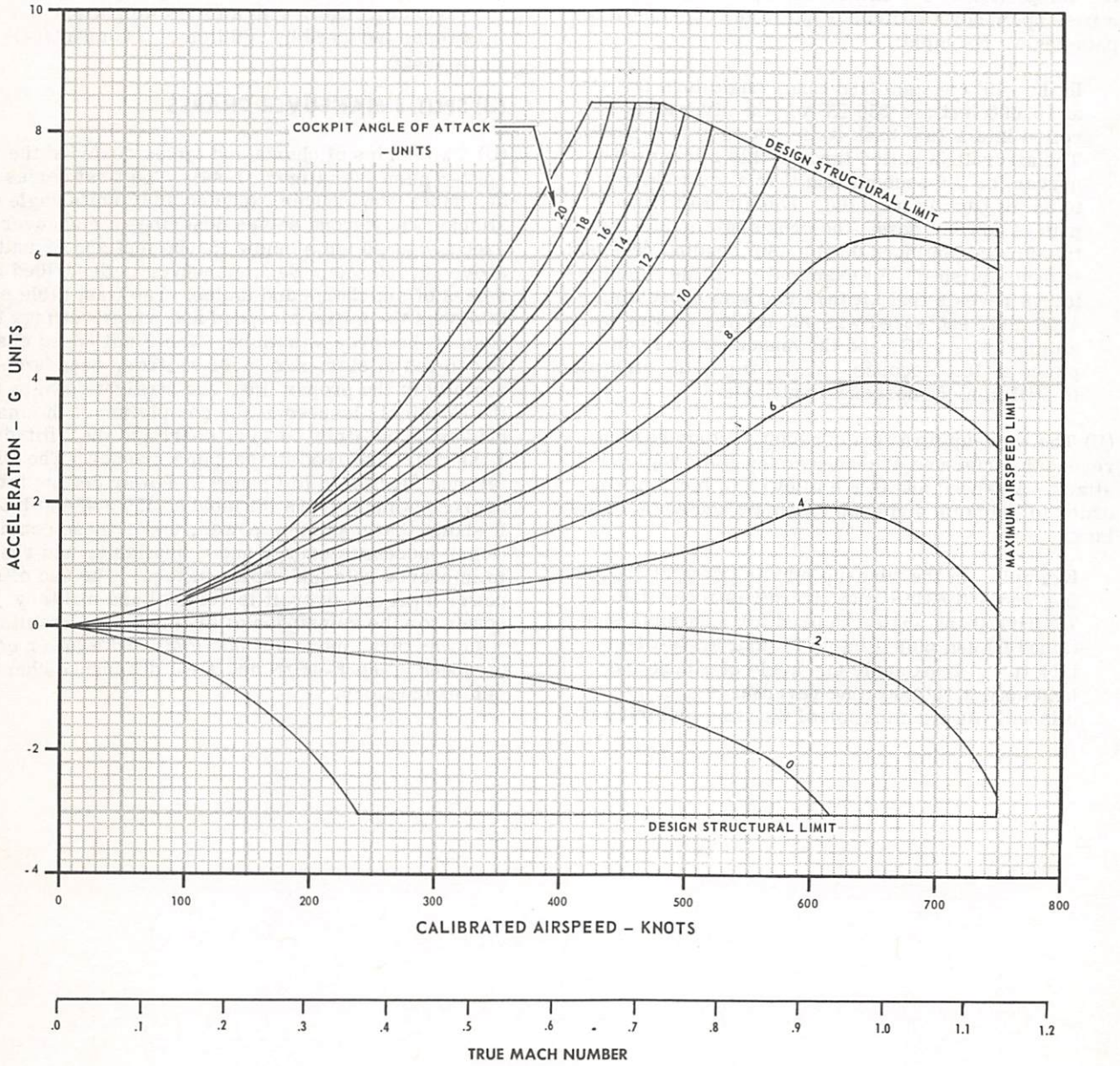
GROSS WEIGHT 37,500 POUNDS

AIRPLANE CONFIGURATION

CLEAN
OR
(4) AIM-7

REMARKS

F-4B(2)J79-GE-8 ENGINES
F-4J(2)J79-GE-10 ENGINES
ICAO STANDARD DAY



UNCLASSIFIED

FDB-1T-(46-1)

Figure 1-37 (U) (Sheet 1 of 2)

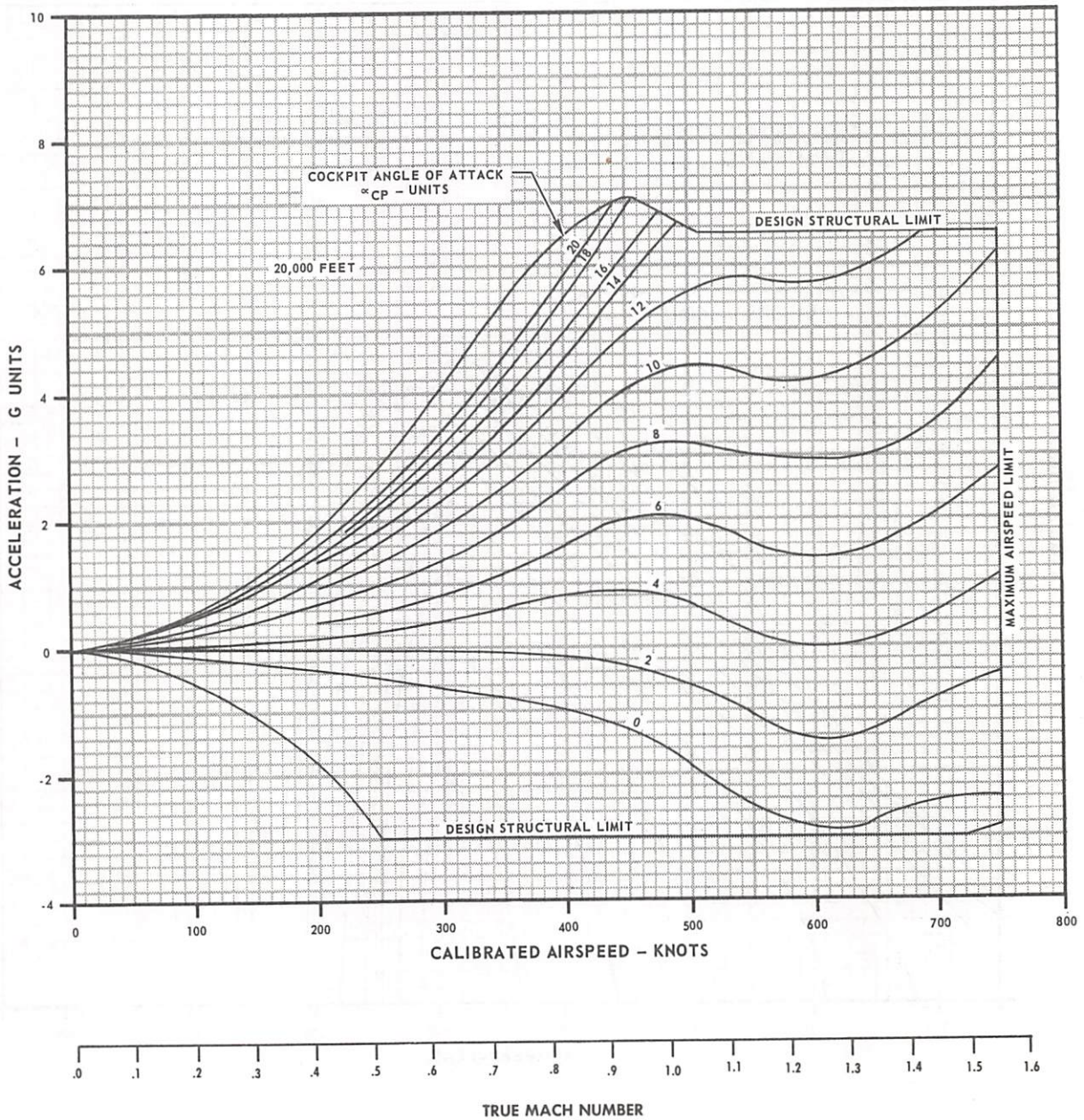
SYMMETRICAL FLIGHT V-N DIAGRAM

ALTITUDE 20,000 FEET

GROSS WEIGHT 37,500 POUNDS

AIRPLANE CONFIGURATION
CLEAN
OR
(4) AIM-7

REMARKS
F-4B(2)J79-GE-8 ENGINES
F-4J(2)J79-GE-10 ENGINES
ICAO STANDARD DAY



UNCLASSIFIED

FDB-1T-(46-2)

Figure 1-37 (U) (Sheet 2 of 2)

F-4B MANEUVERABILITY DIAGRAM

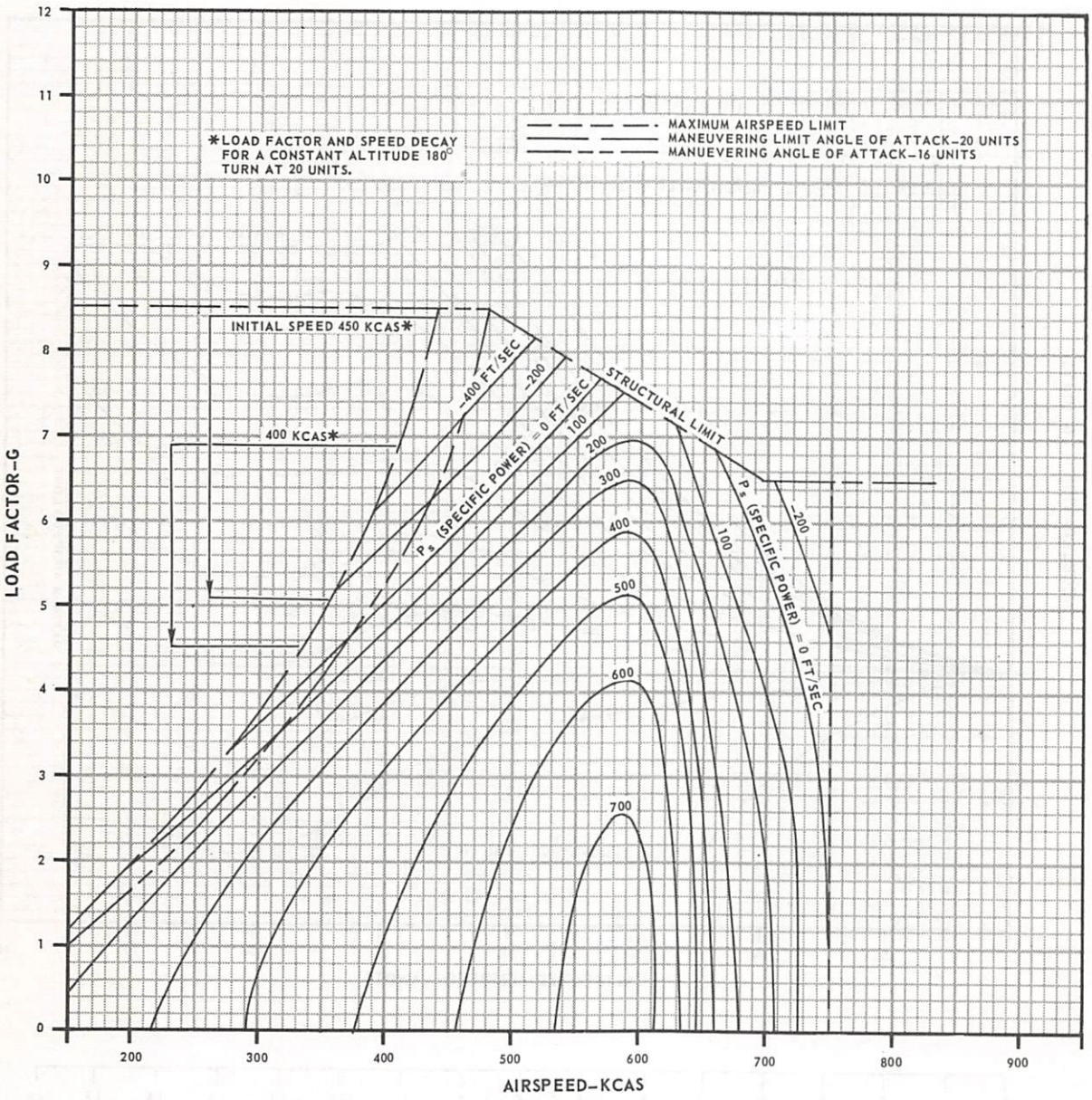
MAXIMUM POWER
SEA LEVEL
GROSS WEIGHT-37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

(2) J79-GE-8 ENGINES

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(47-1)

Figure 1-38 (U) (Sheet 1 of 8)

F-4B MANEUVERABILITY DIAGRAM

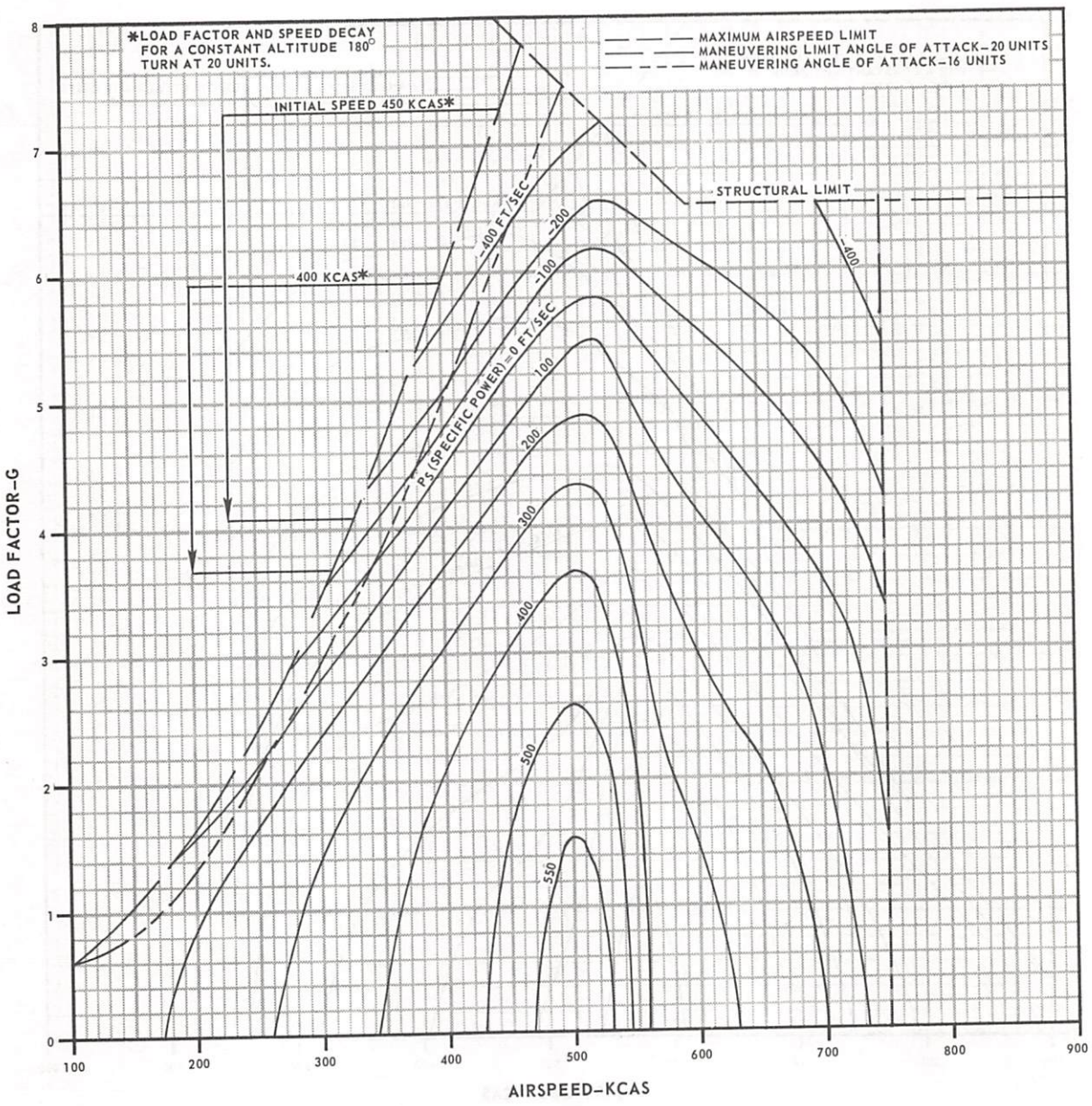
MAXIMUM POWER
10,000 FEET
GROSS WEIGHT-37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

(2) J79-GE-8 ENGINES

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED., FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(47-2)

Figure 1-38 (U) (Sheet 2 of 8)

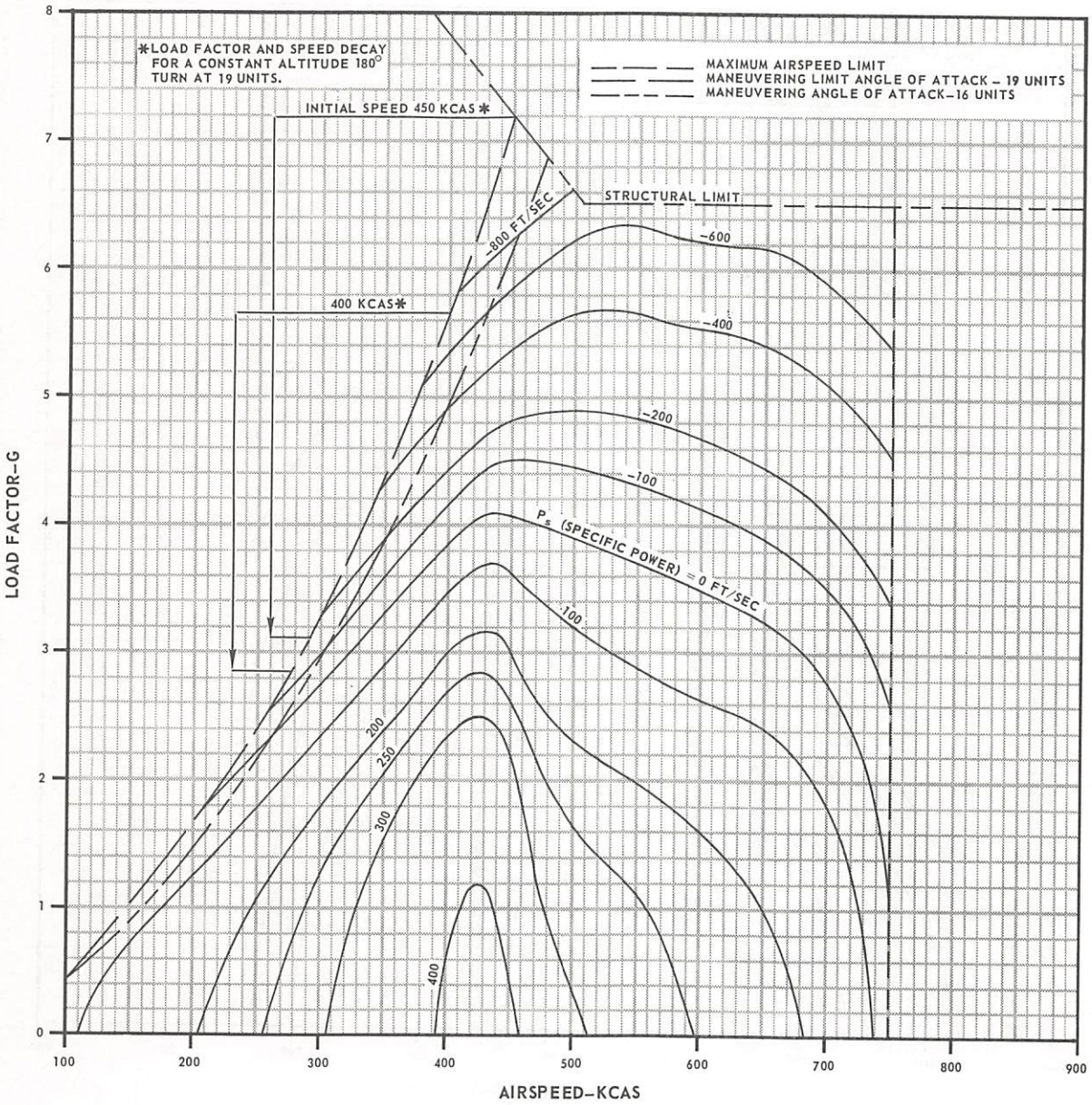
F-4B MANEUVERABILITY DIAGRAM

MAXIMUM POWER
GROSS WEIGHT - 37,500 POUNDS
20,000 FEET

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

REMARKS
(2) J79-GE-8 ENGINES

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(47-3)

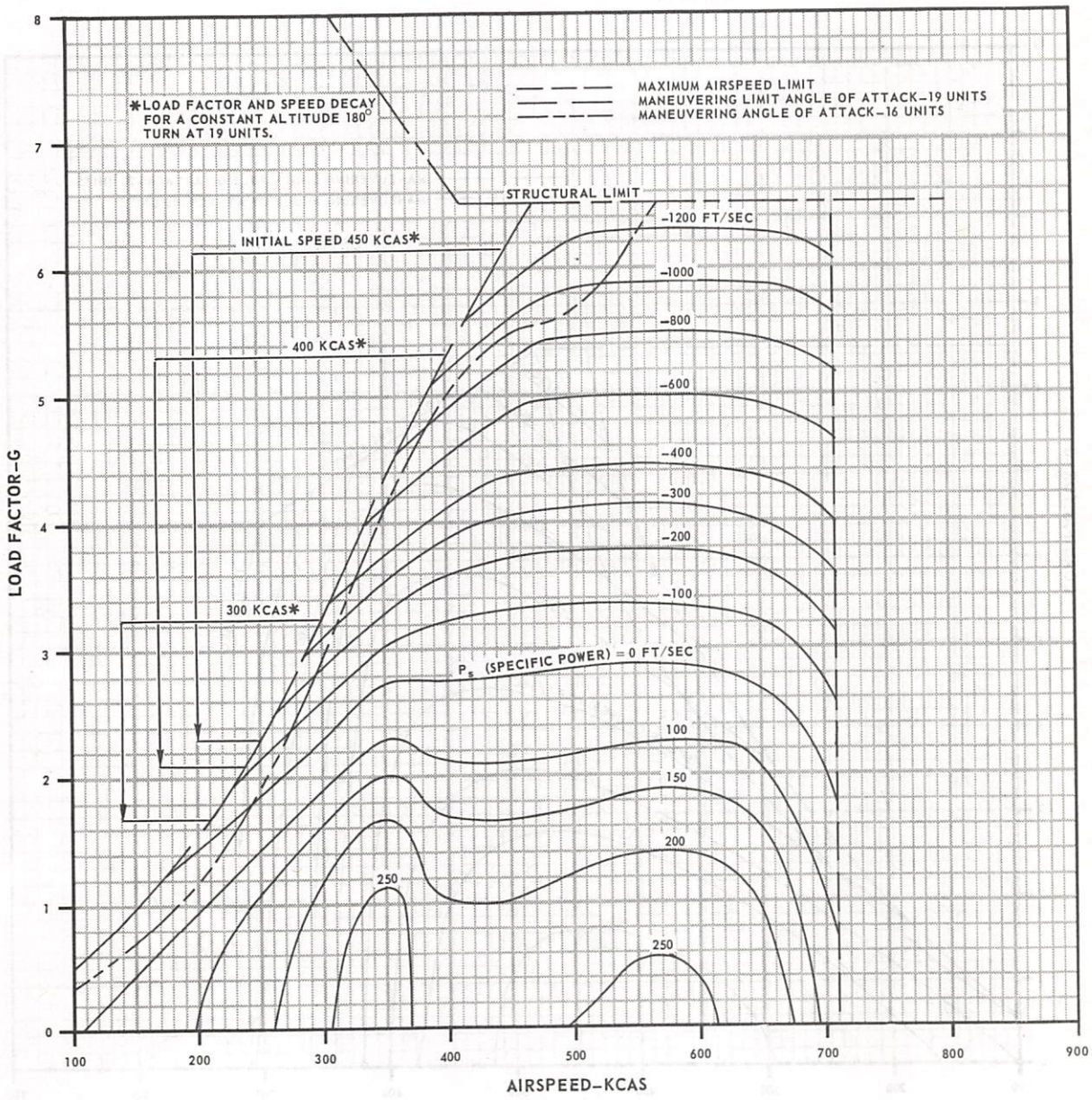
Figure 1-38 (U) (Sheet 3 of 8)

F-4B MANEUVERABILITY DIAGRAM
MAXIMUM POWER
30,000 FEET
GROSS WEIGHT - 37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

REMARKS
(2) J79-GE-8 ENGINES

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED
FDB-1T-(47-4)

Figure 1-38 (U) (Sheet 4 of 8)

F-4B MANEUVERABILITY DIAGRAM

MILITARY POWER
SEA LEVEL
GROSS WEIGHT - 37,500 POUNDS

REMARKS

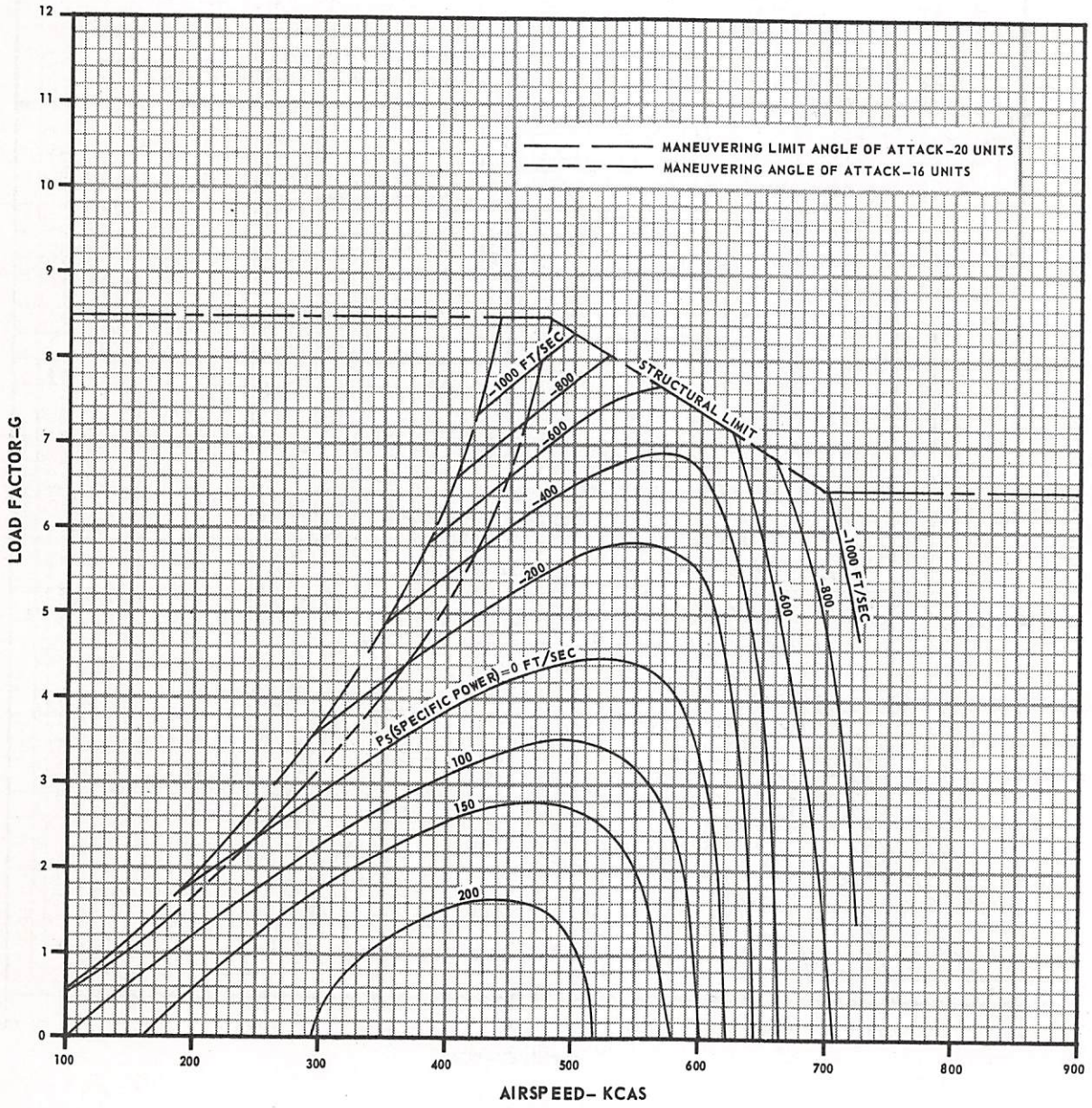
(2) J79-GE-8 ENGINES

AIRPLANE CONFIGURATION

(4) AIM-7E AND (4) AIM-9D

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(47-5)

Figure 1-38 (U) (Sheet 5 of 8)

F-4B MANEUVERABILITY DIAGRAM

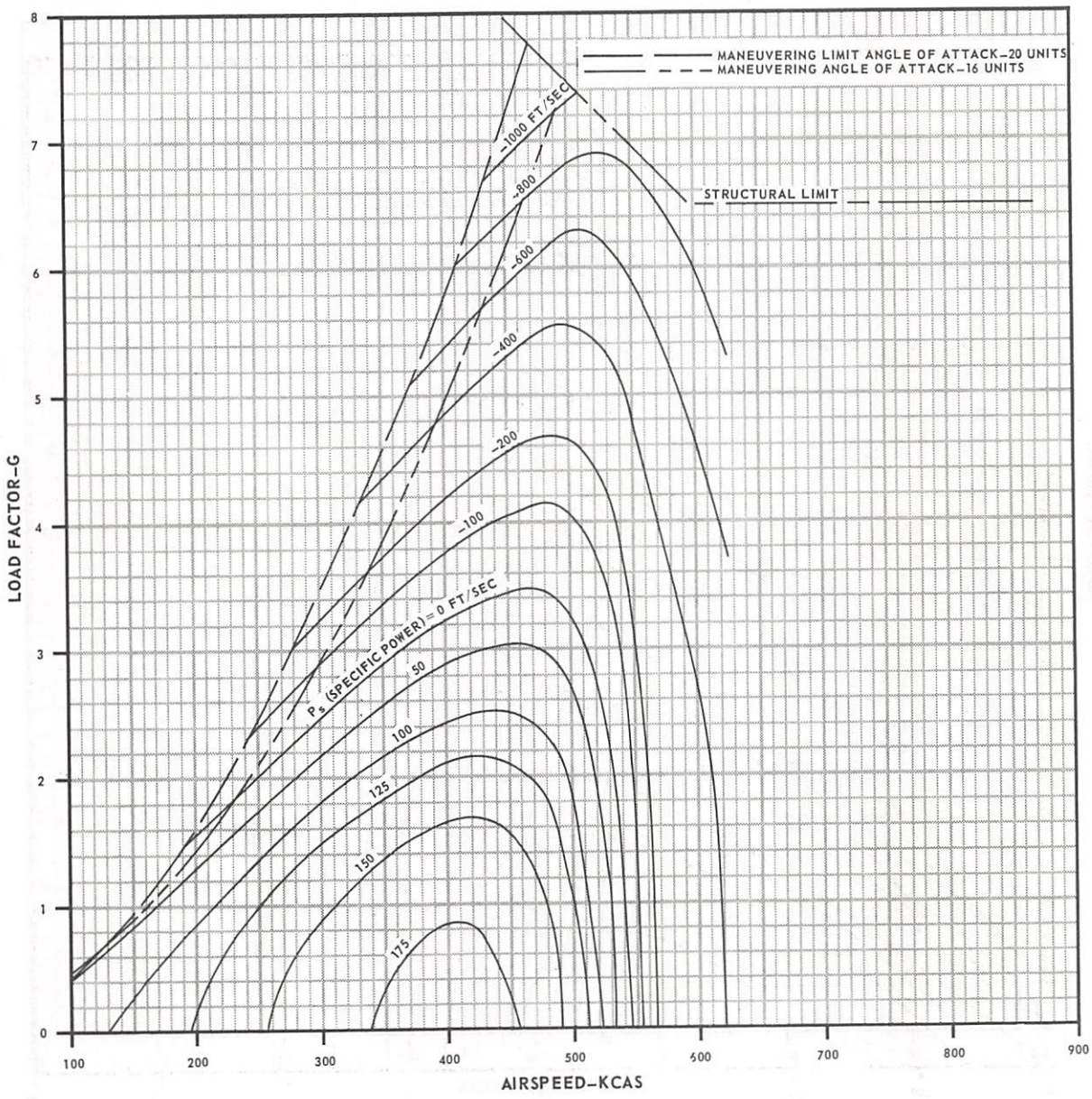
MILITARY POWER
10,000 FEET
GROSS WEIGHT - 37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

(2) J79-GE-8 ENGINES

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(47-6)

Figure 1-38 (U) (Sheet 6 of 8)

F-4B MANEUVERABILITY DIAGRAM

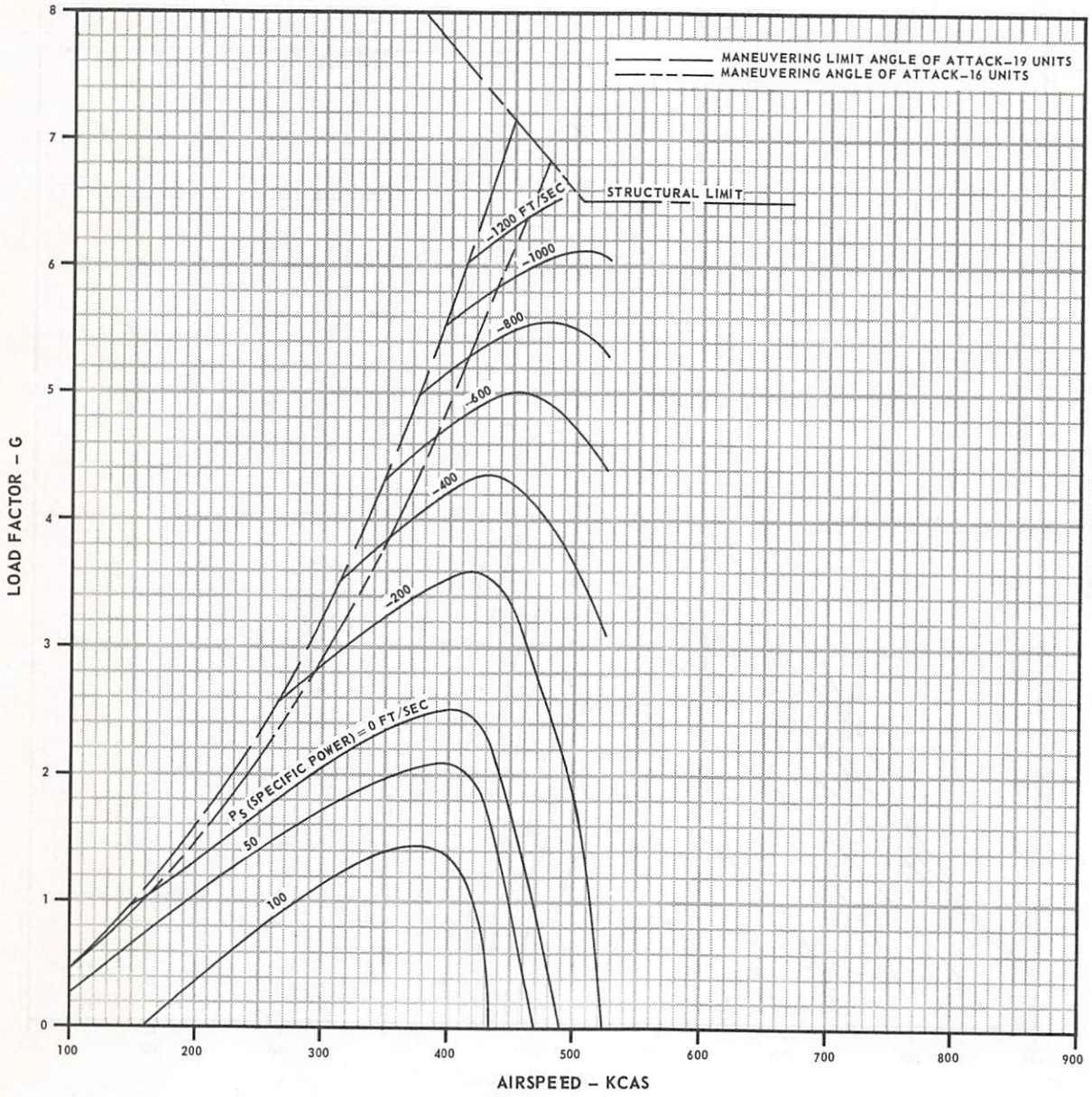
MILITARY POWER
20,000 FEET
GROSS WEIGHT – 37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7 AND (4) AIM-9D

REMARKS
ENGINE(S): (2) J79-GE-8

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(47-7)

Figure 1-38 (U) (Sheet 7 of 8)

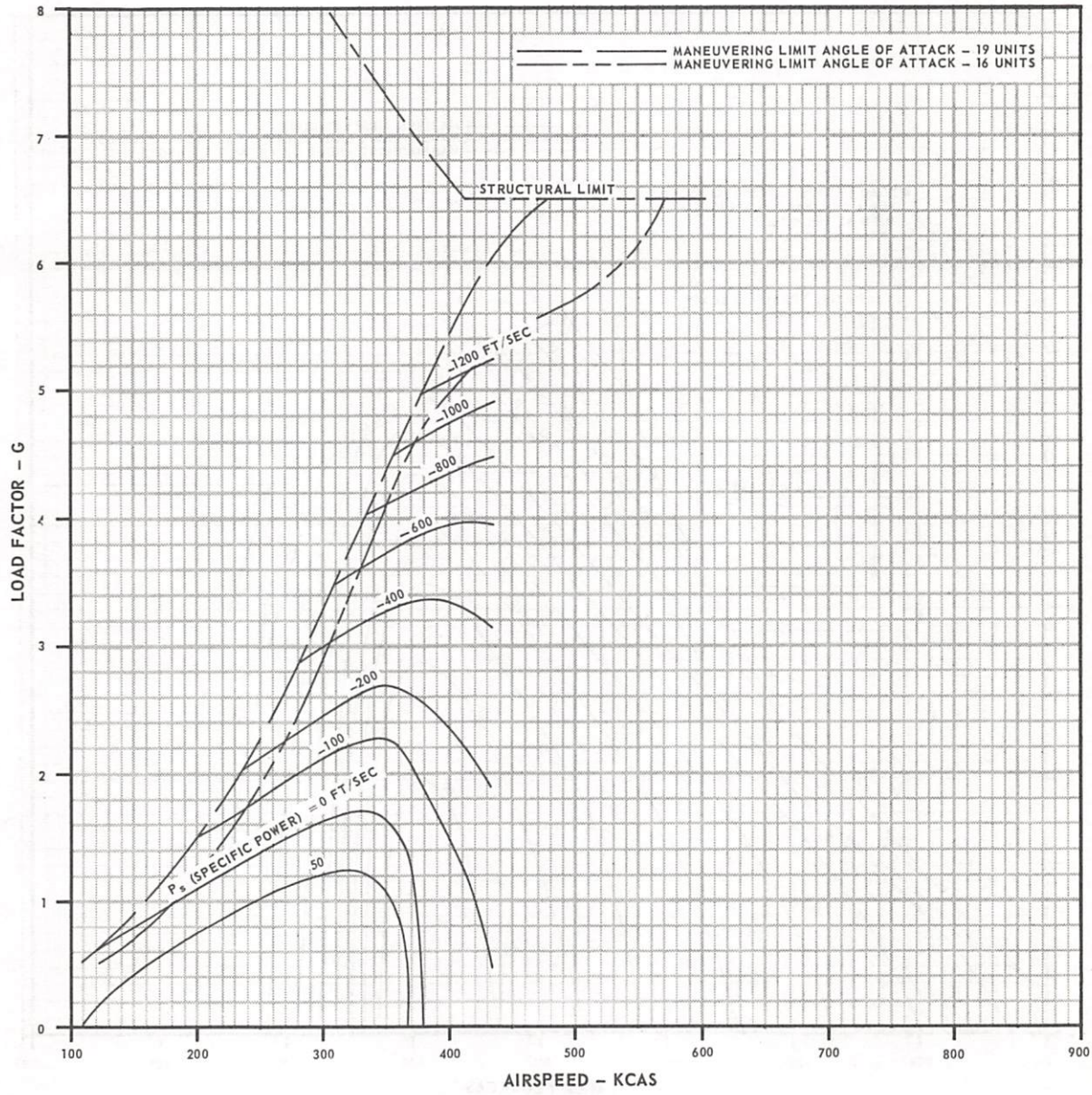
F-4B MANEUVERABILITY DIAGRAM

MILITARY POWER
30,000 FEET
GROSS WEIGHT - 37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

REMARKS
(2) J79-GE-8 ENGINES

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED
FDB-1T-(47-8)

Figure 1-38 (U) (Sheet 8 of 8)

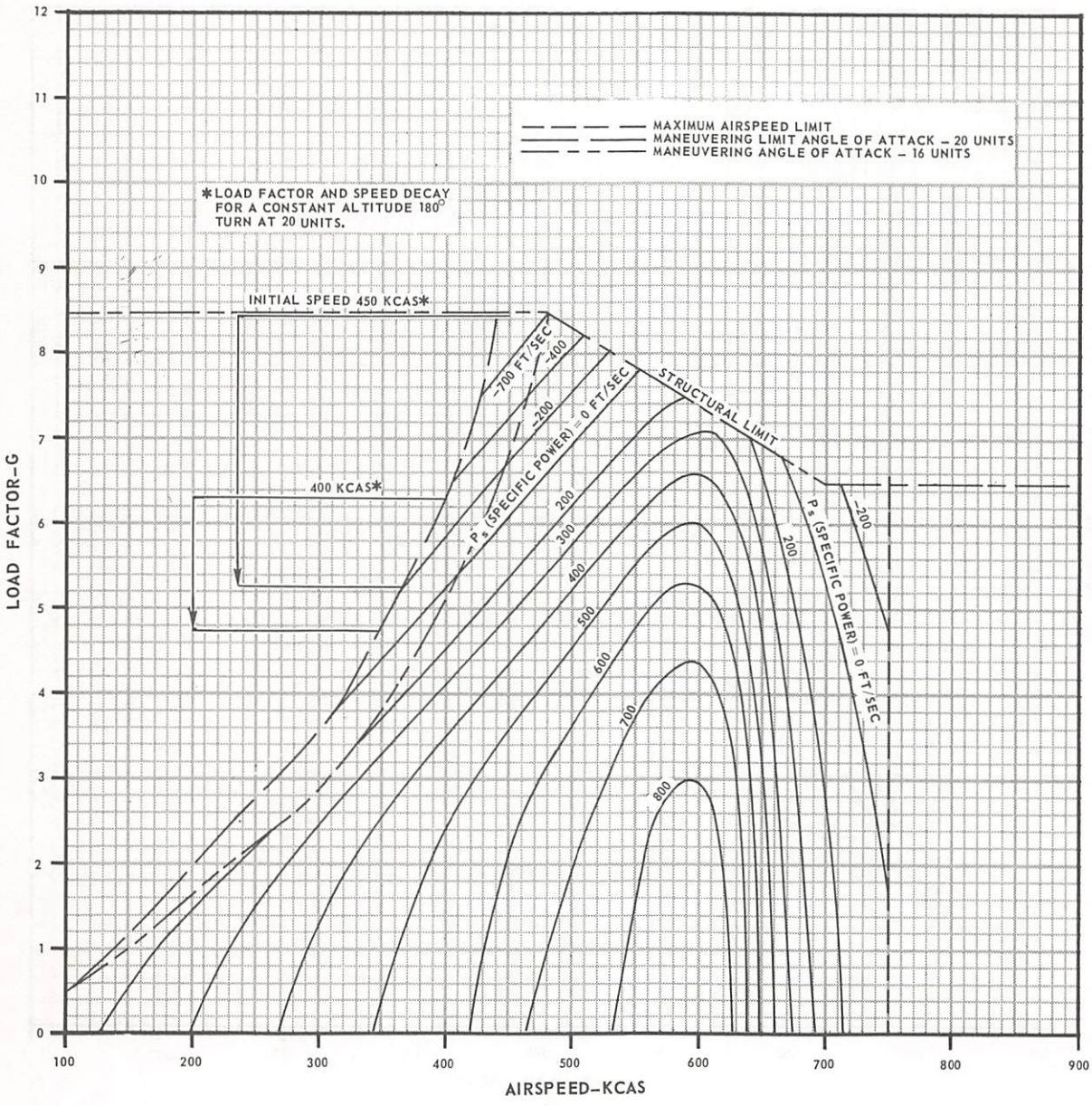
F-4J MANEUVERABILITY DIAGRAM

MAXIMUM POWER
SEA LEVEL
GROSS WEIGHT - 37,500 POUNDS

REMARKS
(2) J79-GE-10 ENGINES

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D



UNCLASSIFIED

FDB-1T-(48-1)

Figure 1-39 (U) (Sheet 1 of 8)

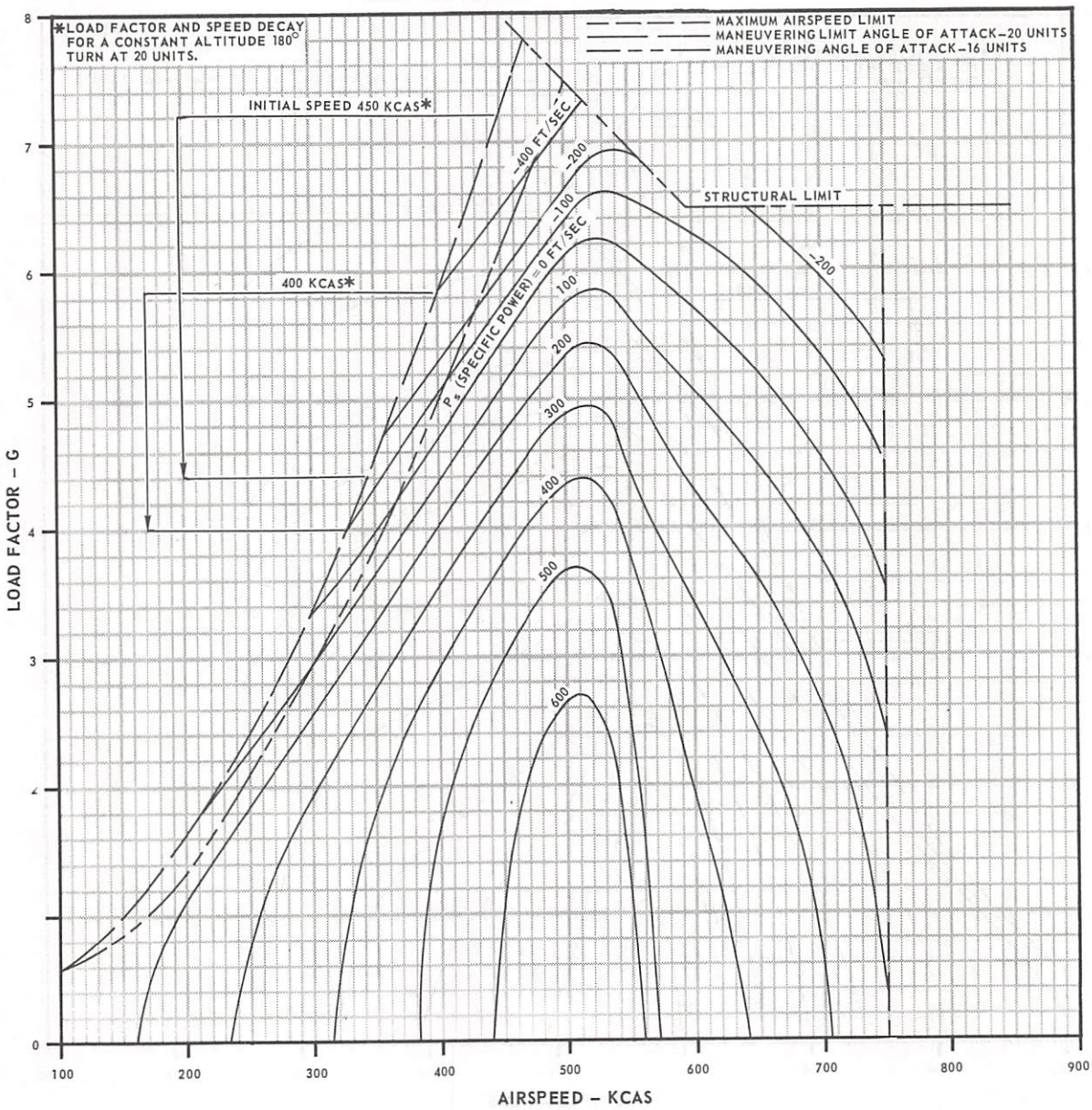
F-4J MANEUVERABILITY DIAGRAM

MAXIMUM POWER
10,000 FEET
GROSS WEIGHT - 37,500 POUNDS

REMARKS
(2) J79-GE-10 ENGINES

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D



UNCLASSIFIED
FDB-1T-(48-2)

Figure 1-39 (U) (Sheet 2 of 8)

F-4J MANEUVERABILITY DIAGRAM

MAXIMUM POWER
20,000 FEET
GROSS WEIGHT - 37,500 POUNDS

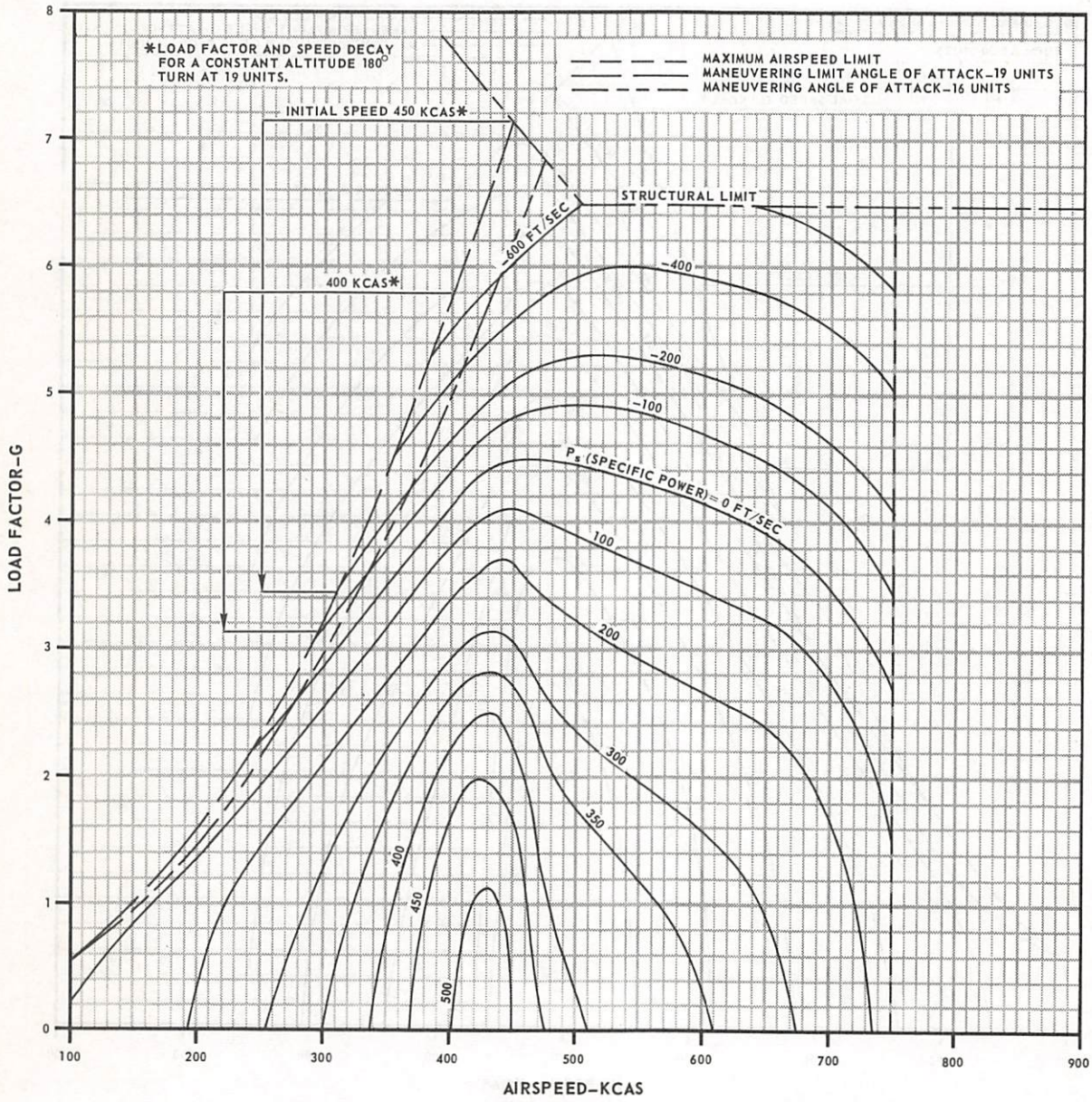
REMARKS

(2) J79-GE-10 ENGINES

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(48-3)

Figure 1-39 (U) (Sheet 3 of 8)

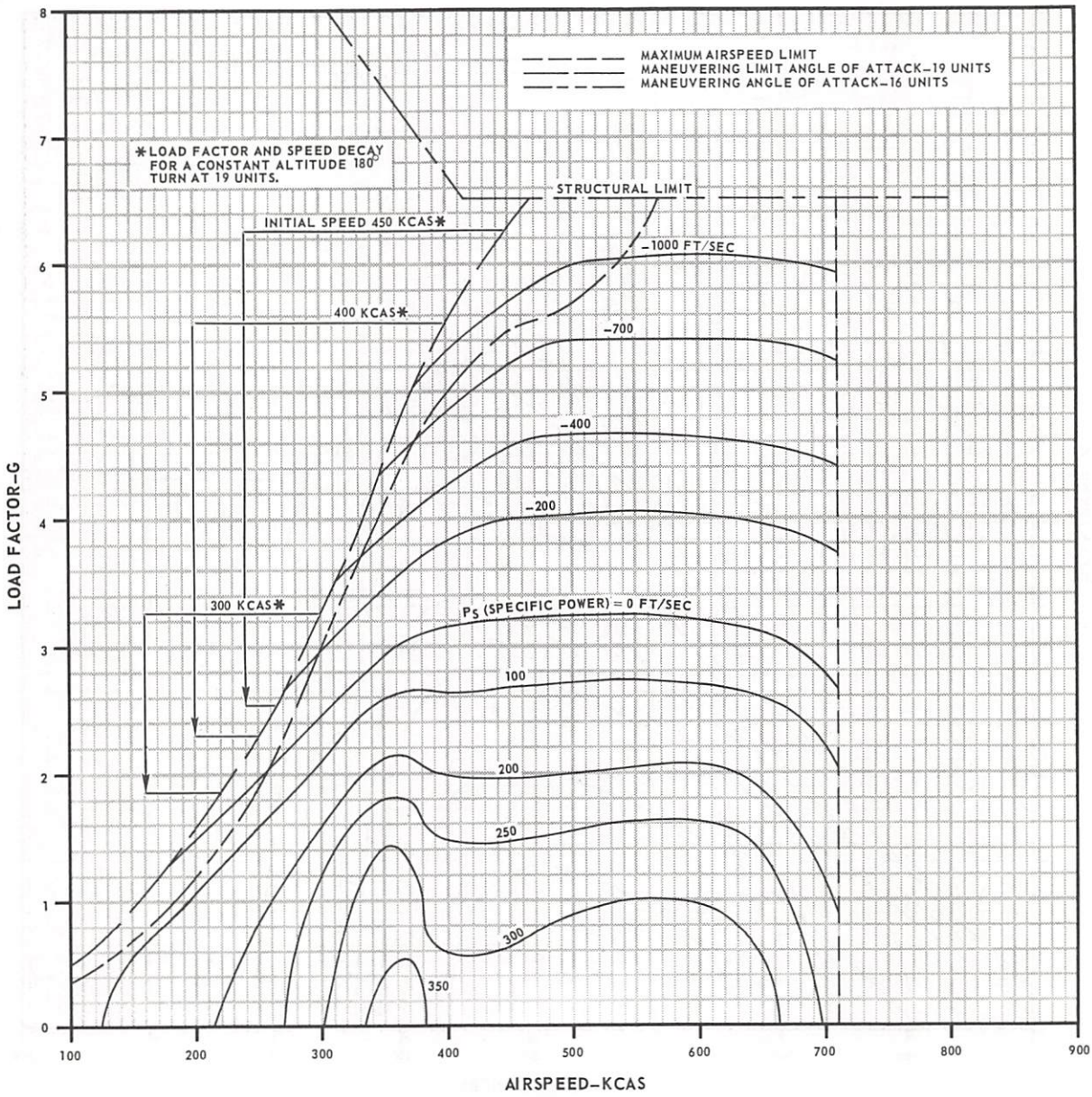
F-4J MANEUVERABILITY DIAGRAM

MAXIMUM POWER
30,000 FEET
GROSS WEIGHT - 37,500 POUNDS

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

REMARKS
(2) J-79-GE-10 ENGINES

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED
FDB-1T-(48-4)

Figure 1-39 (U) (Sheet 4 of 8)

F-4J MANEUVERABILITY DIAGRAM

MILITARY POWER
SEA LEVEL
GROSS WEIGHT - 37,500 POUNDS

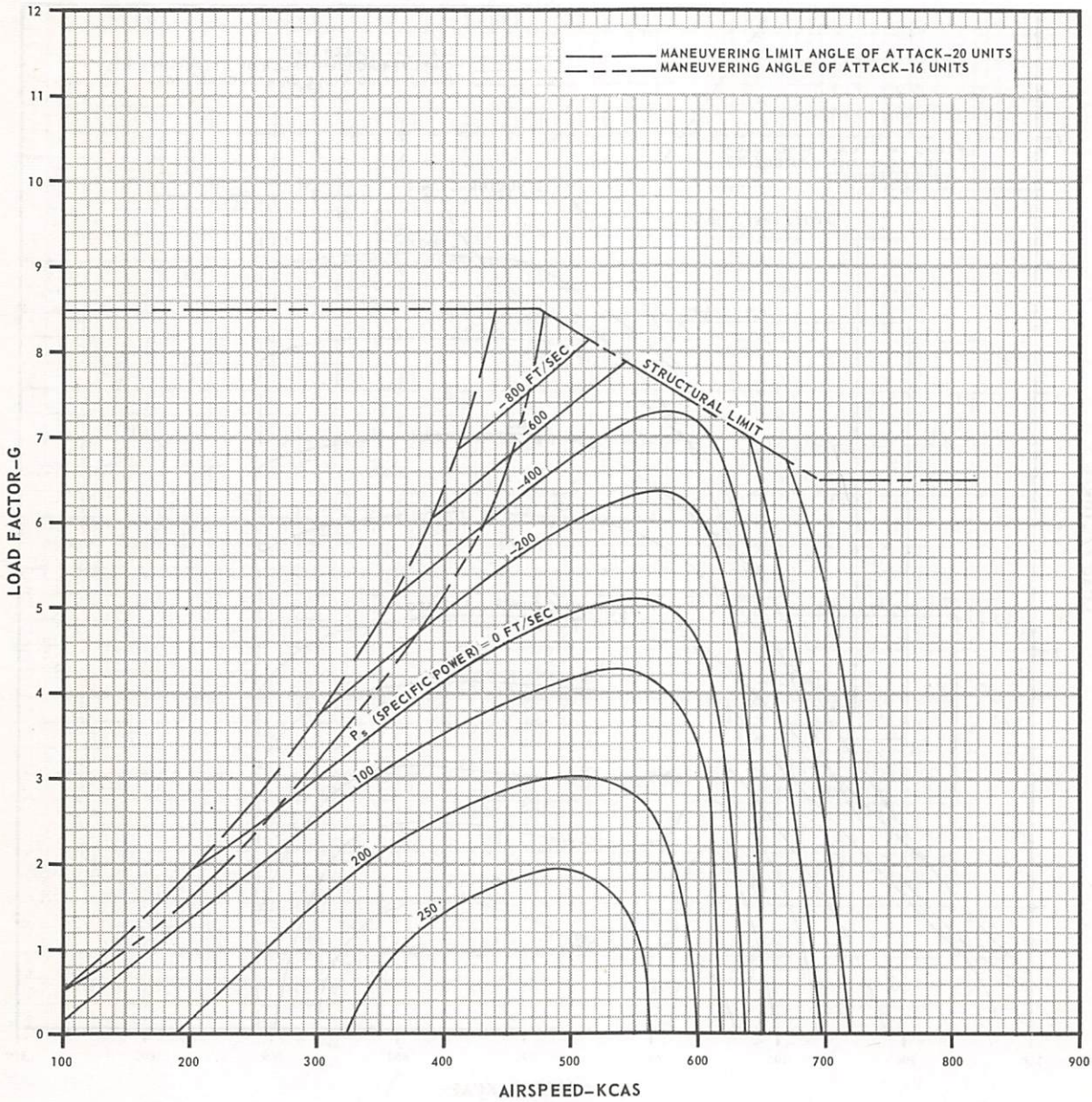
REMARKS

(2) J79-GE-10 ENGINES

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(48-5)

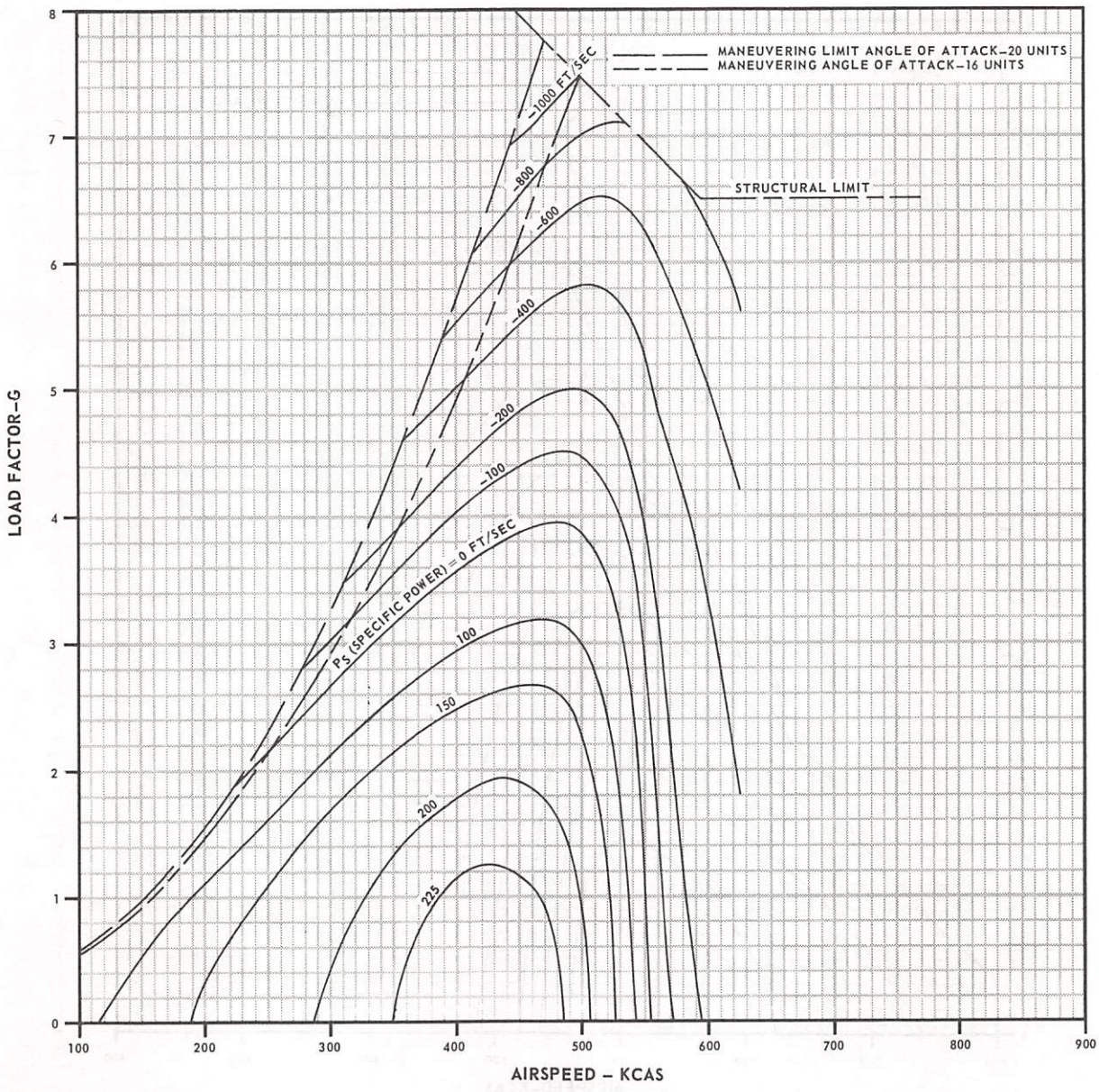
Figure 1-39 (U) (Sheet 5 of 8)

F-4J MANEUVERABILITY DIAGRAM
MILITARY POWER
10,000 FEET
GROSS WEIGHT - 37,500 POUNDS

(2) J79-GE-10 ENGINES

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

NOTE
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(48-6)

Figure 1-39 (U) (Sheet 6 of 8)

F-4J MANEUVERABILITY DIAGRAM

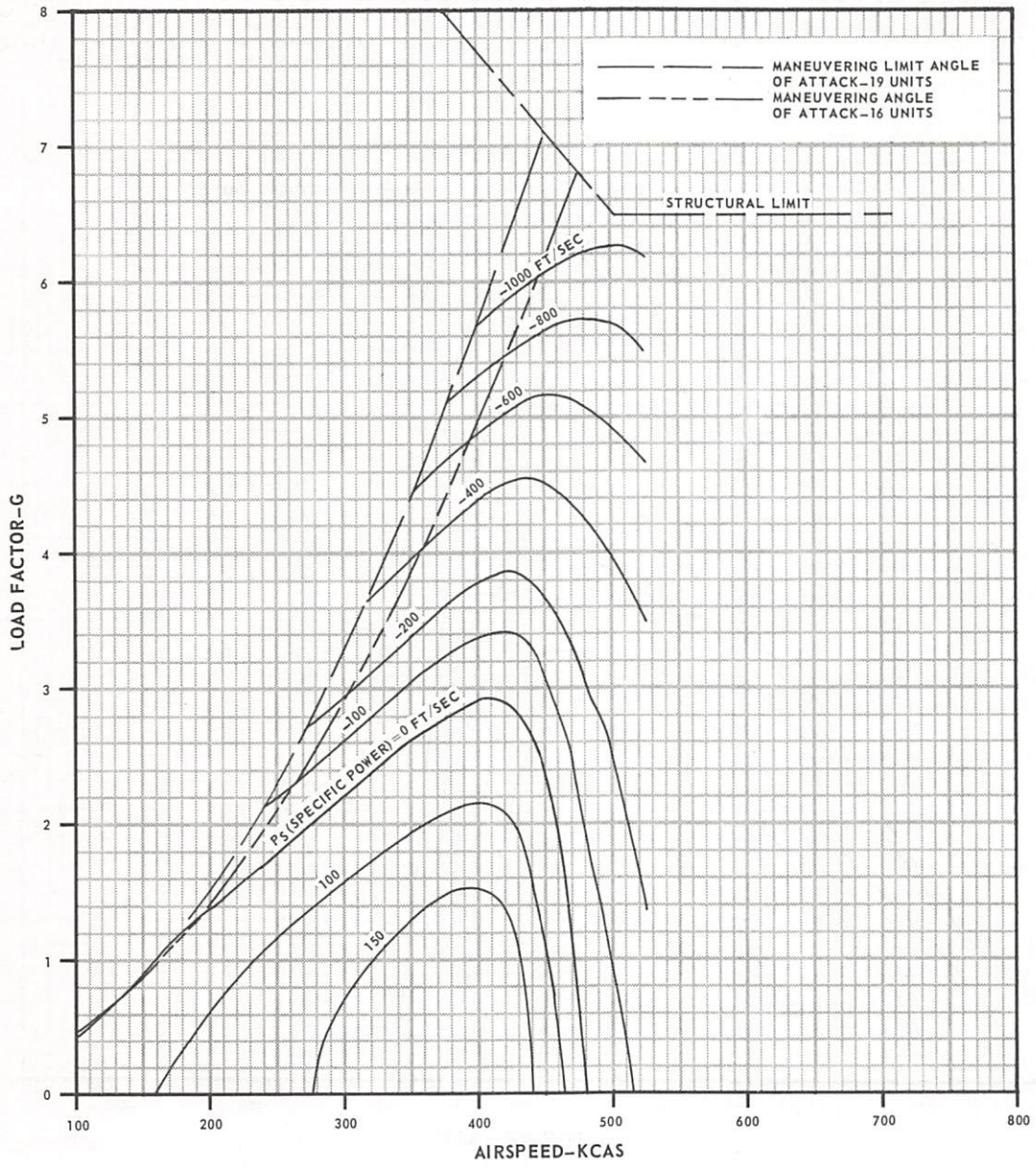
MILITARY POWER
20,000 FEET
GROSS WEIGHT - 37,500 POUNDS

(2) J79-GE-10 ENGINES

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D



UNCLASSIFIED

FDB-1T-(48-7)

Figure 1-39 (U) (Sheet 7 of 8)

F-4J MANEUVERABILITY DIAGRAM

MILITARY POWER
30,000 FEET
GROSS WEIGHT - 37,500 POUNDS

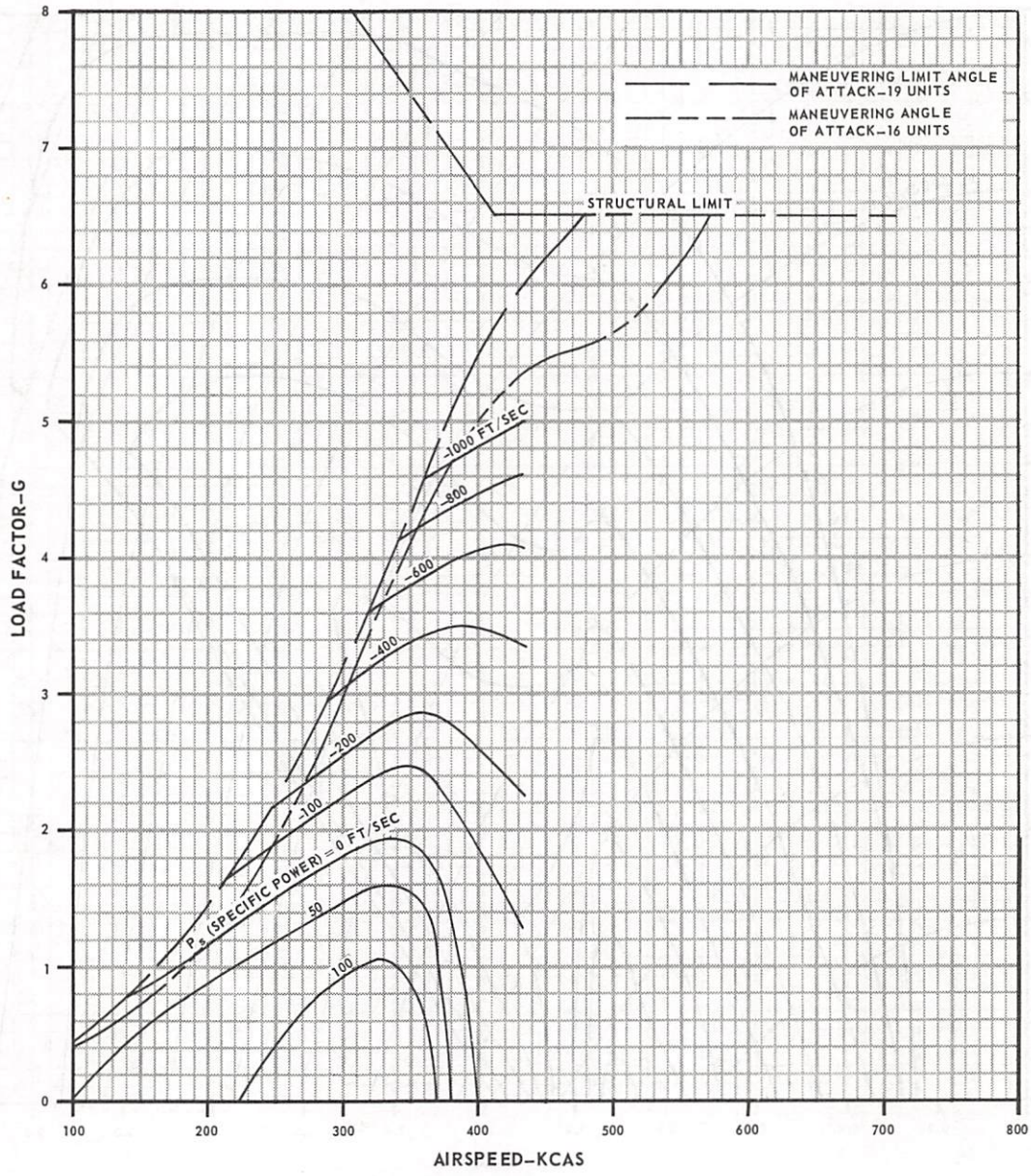
AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

REMARKS

(2) J79-GE-10 ENGINES

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.



UNCLASSIFIED

FDB-1T-(48-8)

Figure 1-39 (U) (Sheet 8 of 8)

H-M DIAGRAM
MAXIMUM POWER
LOAD FACTOR-1G
ONE-HALF INTERNAL FUEL

AIRPLANE CONFIGURATION
(4) AIM-7E

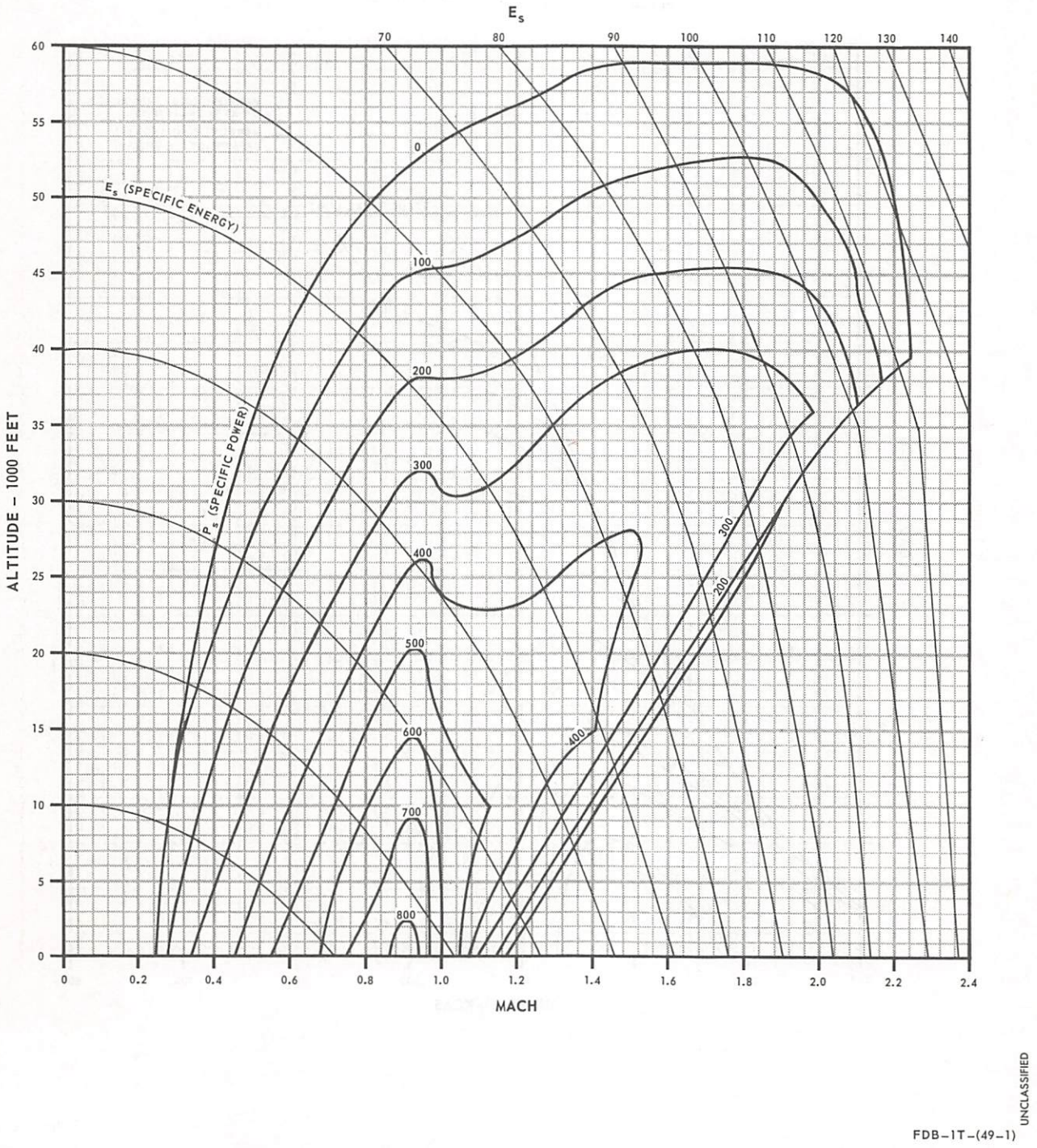
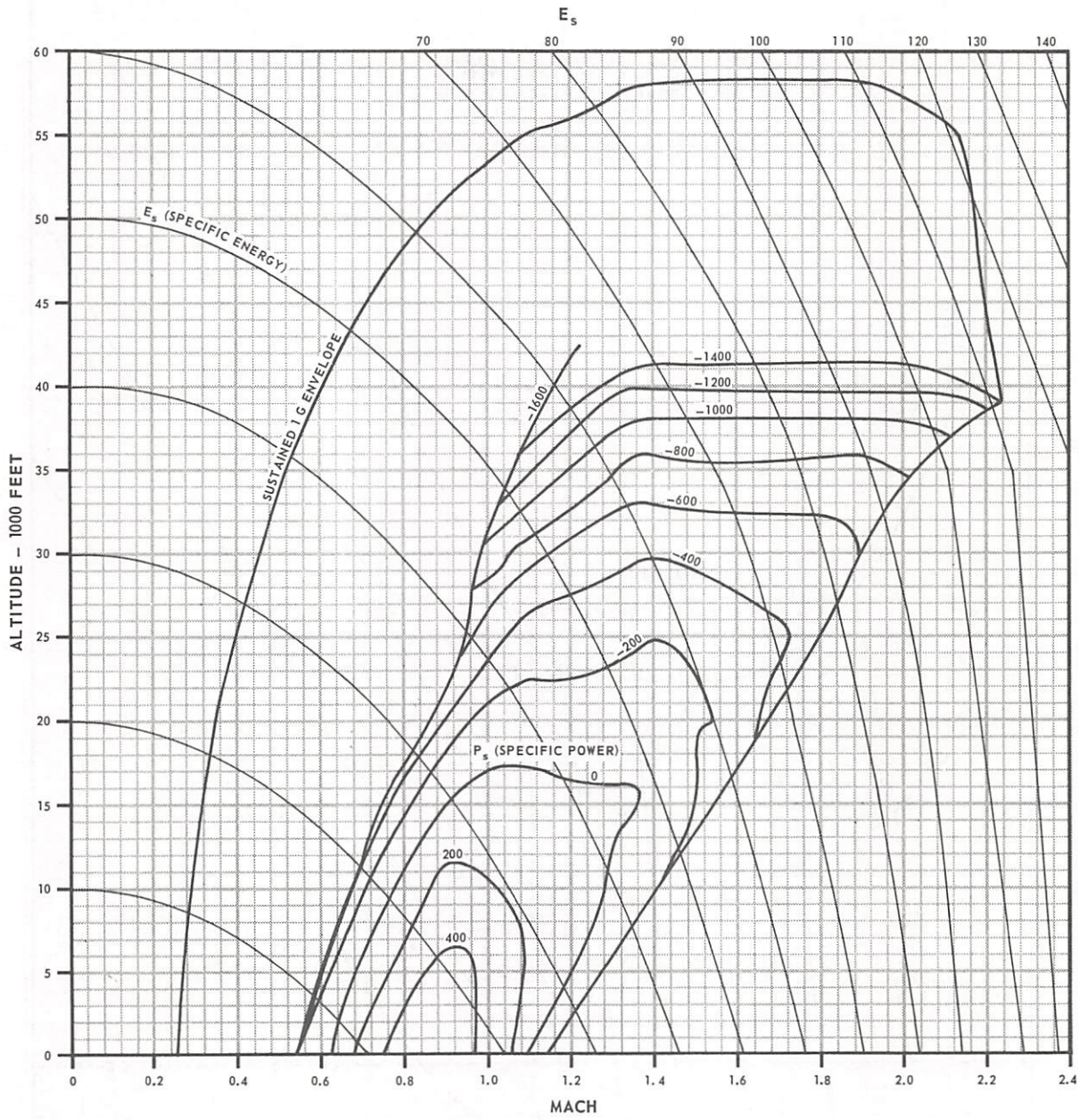


Figure 1-40 (U) (Sheet 1 of 2)

H-M DIAGRAM

MAXIMUM POWER
LOAD FACTOR-5G
ONE-HALF INTERNAL FUEL

AIRPLANE CONFIGURATION
(4) AIM-7E



UNCLASSIFIED

FDB-1T-(49-2)

Figure 1-40 (U) (Sheet 2 of 2)

F-4B/J INSTANTANEOUS RADIUS OF TURN CAPABILITY

GROSS WEIGHT-37,500 POUNDS

CONFIGURATION

(4) AIM-7E AND (4) AIM-9D

F-4B (2) J79-GE-8 ENGINES
F-4J (2) J79-GE-10 ENGINES

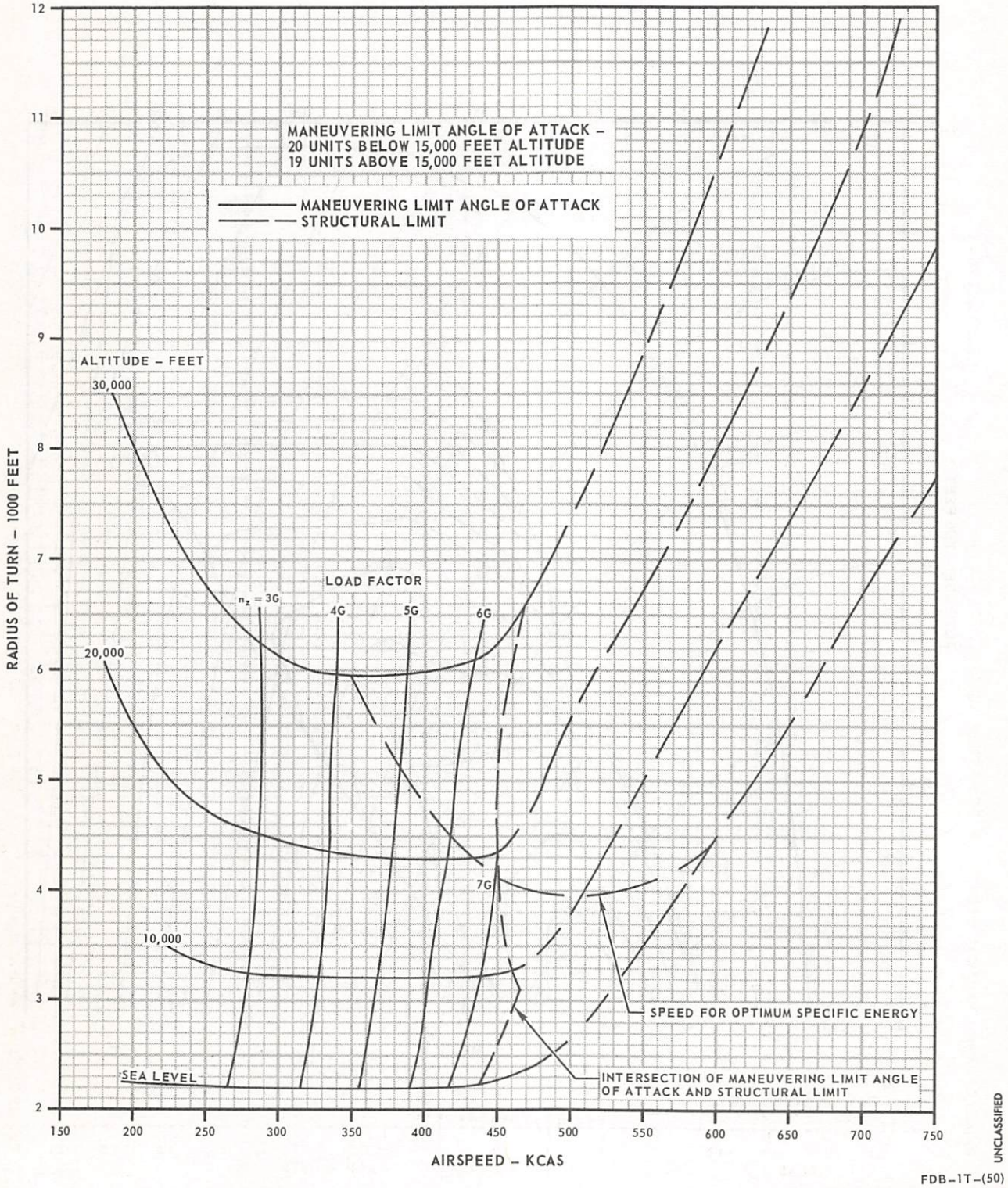


Figure 1-41 (U)

F-4B SUSTAINED G TURN CAPABILITIES

GROSS WEIGHT - 37,500 POUNDS

AIRPLANE CONFIGURATION

(4) AIM-7E AND (4) AIM-9D

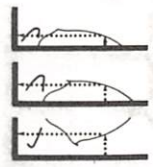
REMARKS

ENGINE(S): (2) J79-GE-8
ICAO STANDARD DAY

NOTE

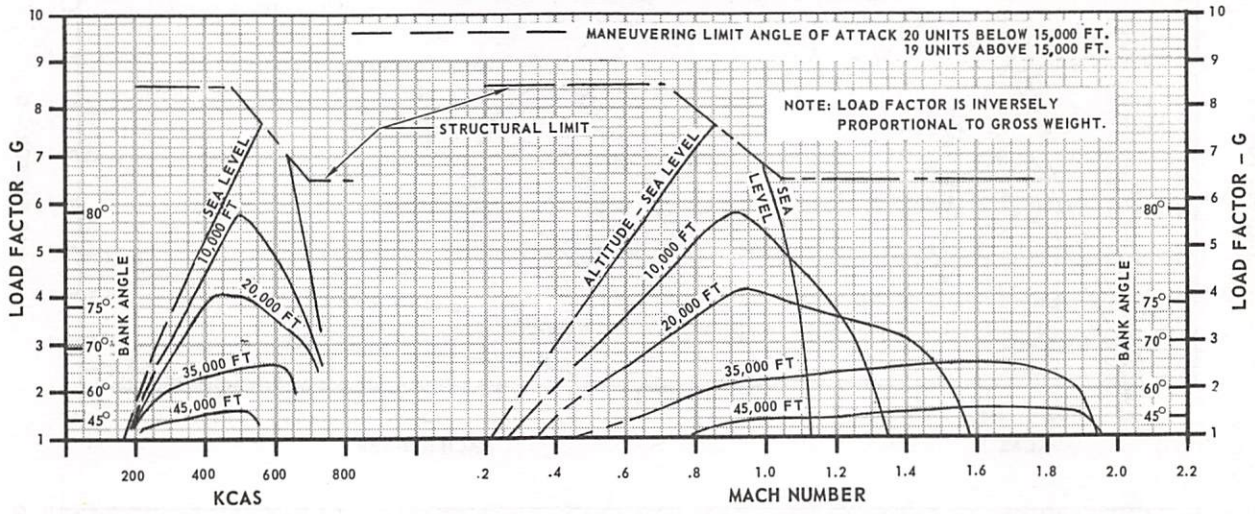
ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

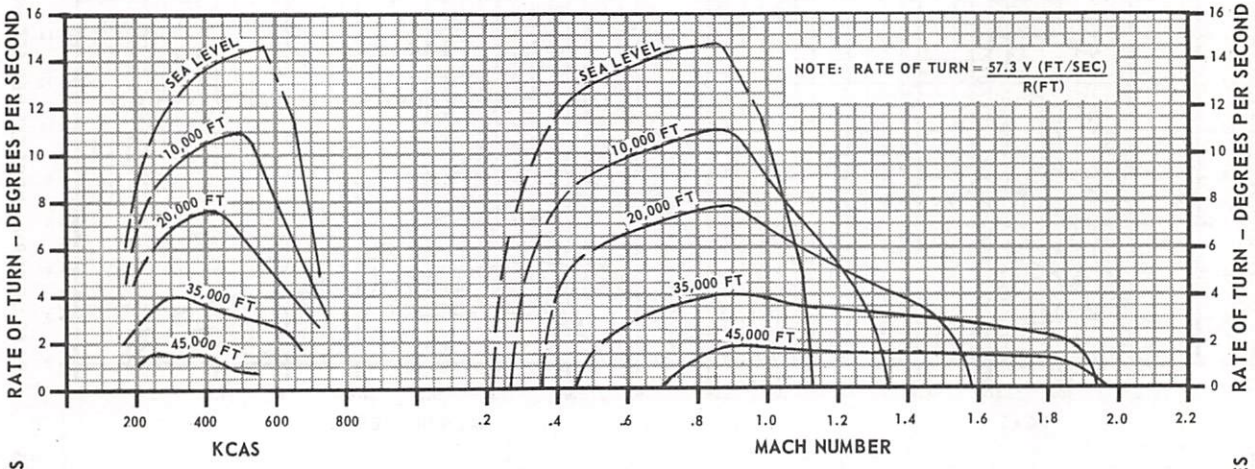
GUIDE

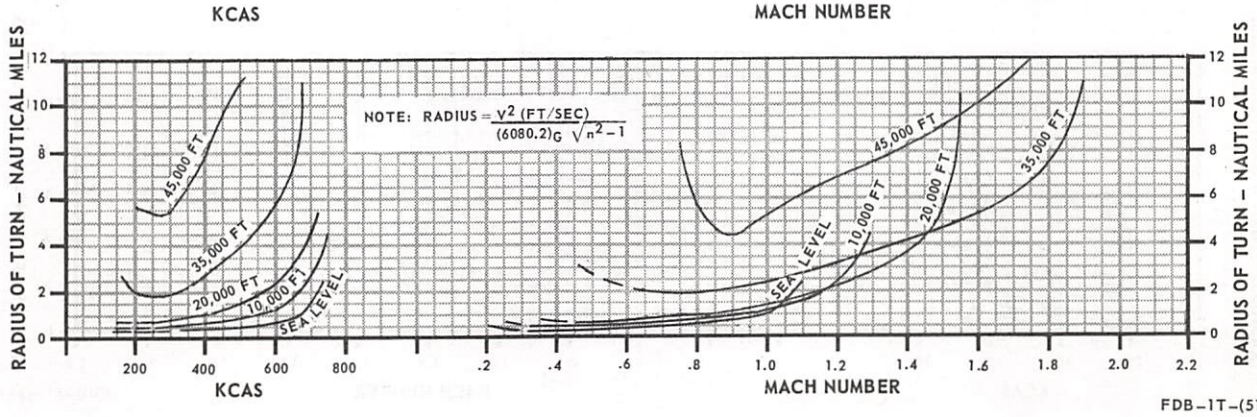


MAXIMUM POWER
CONSTANT SPEED AND ALTITUDE

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL







UNCLASSIFIED

FDB-1T-(51-1)

Figure 1-42 (U)(Sheet 1 of 2)

F-4J SUSTAINED G TURN CAPABILITIES

GROSS WEIGHT - 37,500 POUNDS
MAXIMUM POWER
CONSTANT SPEED AND ALTITUDE

AIRPLANE CONFIGURATION

(4) AIM-7E AND (4) AIM-9D

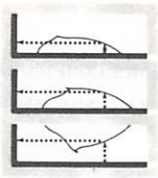
REMARKS

ENGINE(S): (2) J79-GE-10
ICAO STANDARD DAY

NOTE

ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

GUIDE



FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

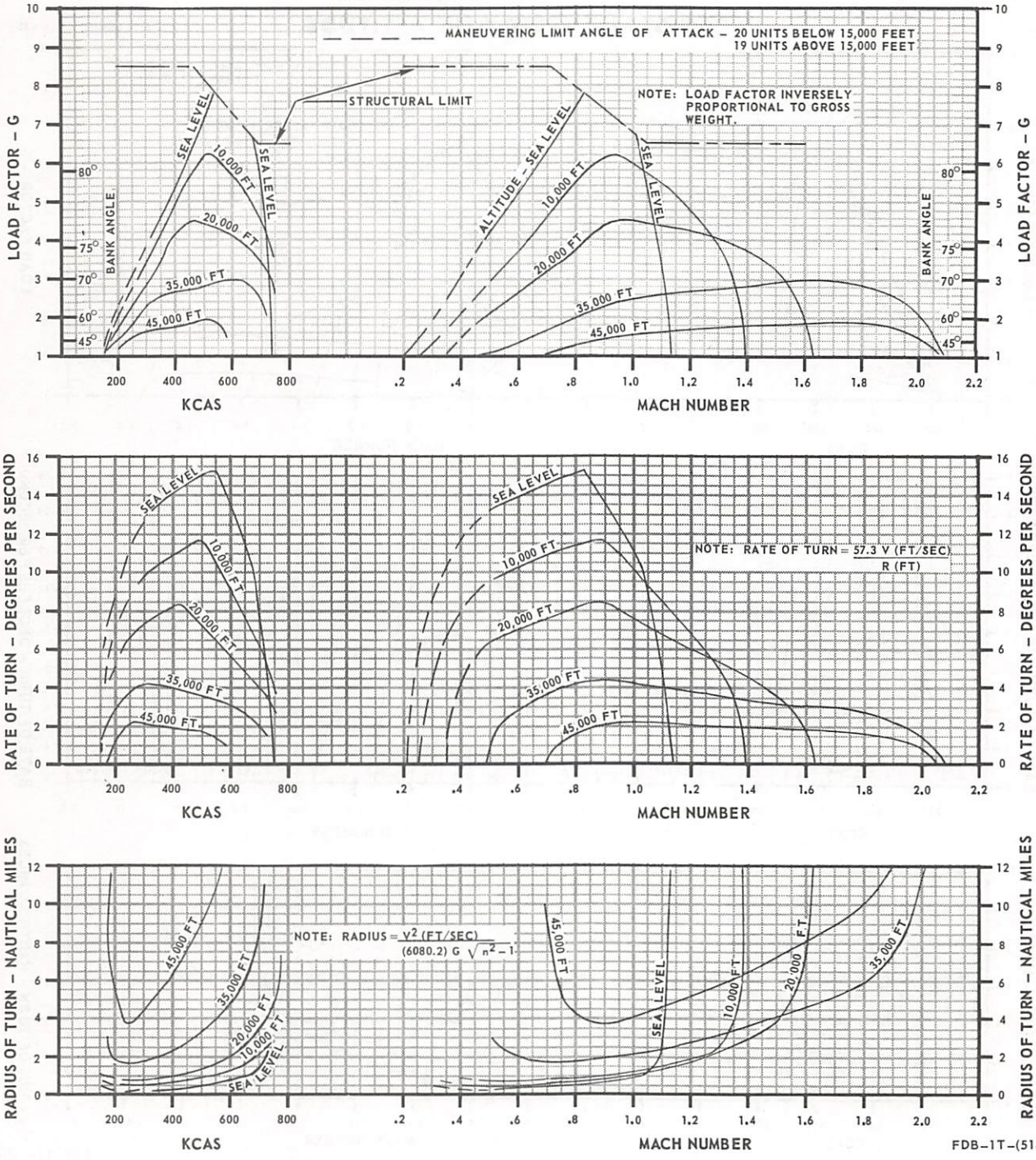


Figure 1-42 (U) (Sheet 2 of 2)

HEADING REVERSALS

DIVING TURNS

GROSS WEIGHT - 37,500 POUNDS

MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E, (4) AIM-9D

ENGINES: (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FT
19 UNITS ABOVE 15,000 FT

NOTES

(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 350 KCAS

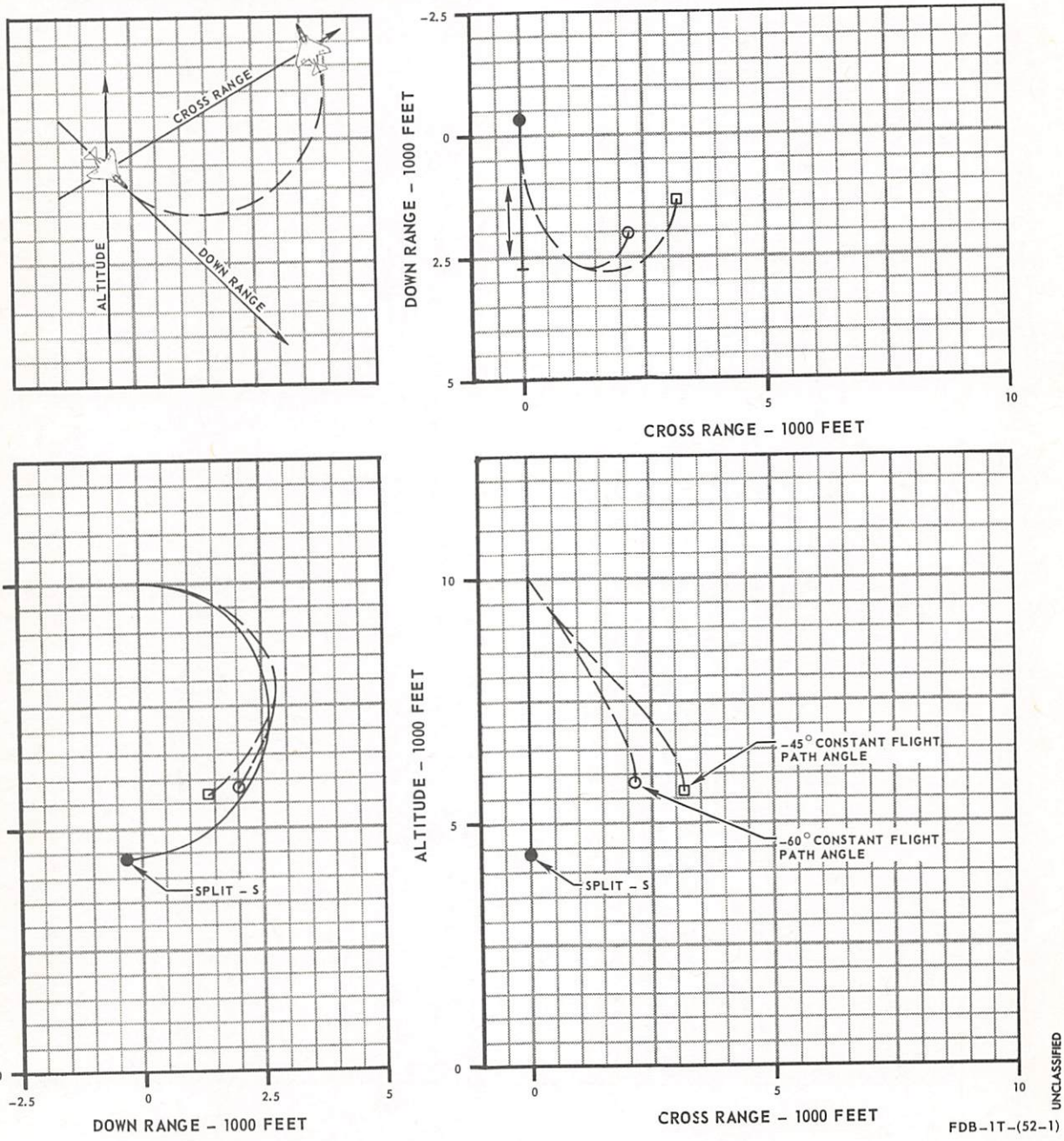


Figure 1-43 (U) (Sheet 1 of 24)

TIME HISTORIES

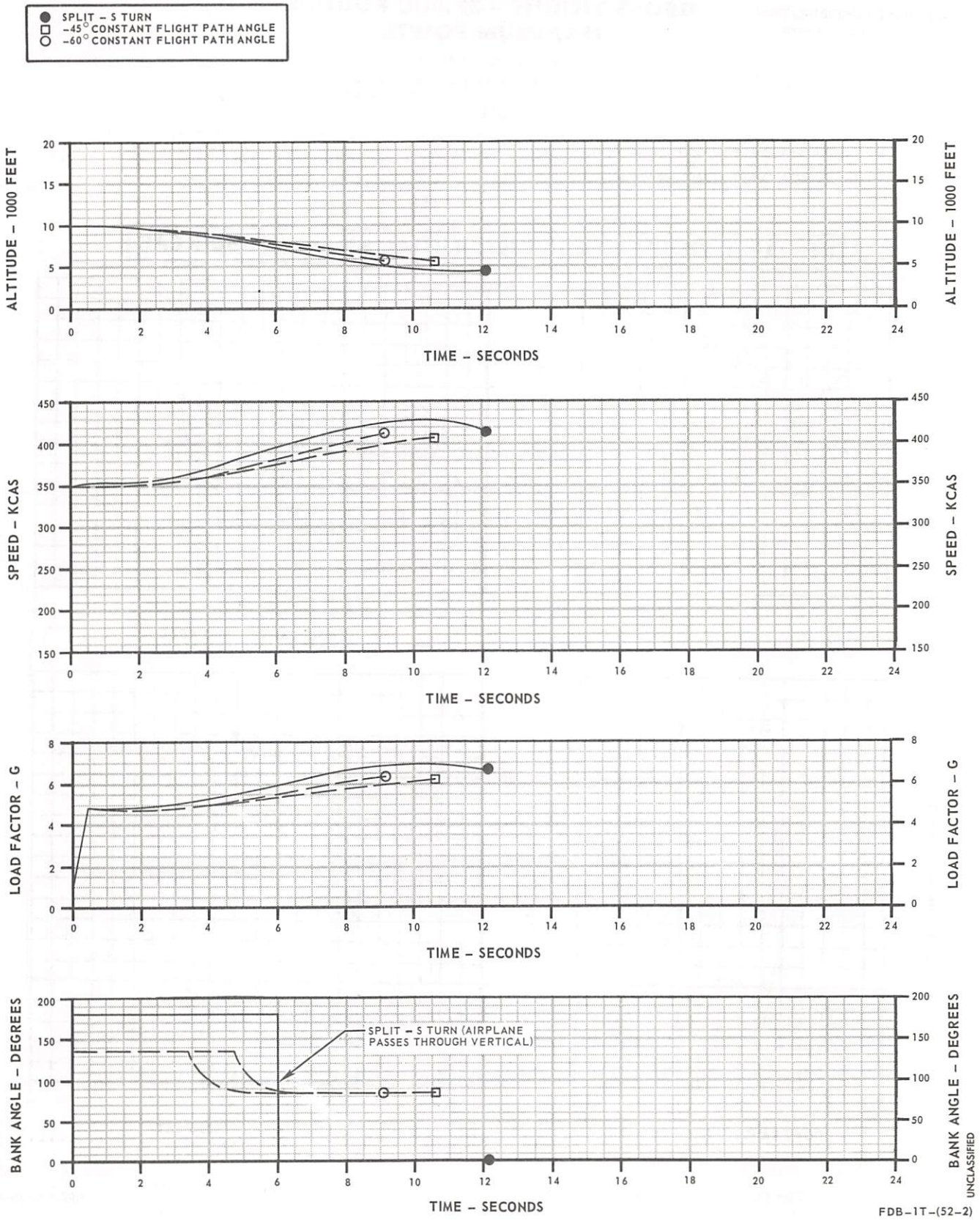


Figure 1-43 (U) (Sheet 2 of 24)

HEADING REVERSALS
LEVEL/CLIMBING TURNS
GROSS WEIGHT - 37,500 POUNDS
MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK - 20 UNITS BELOW 15,000 FT
19 UNITS ABOVE 15,000 FT

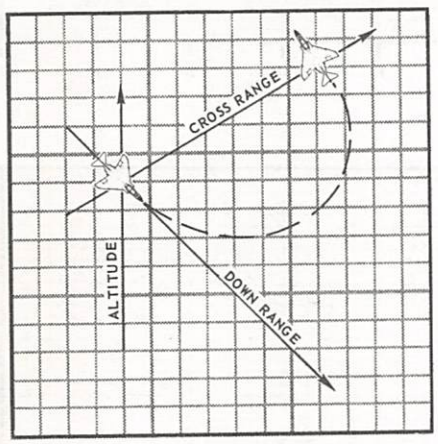
NOTES

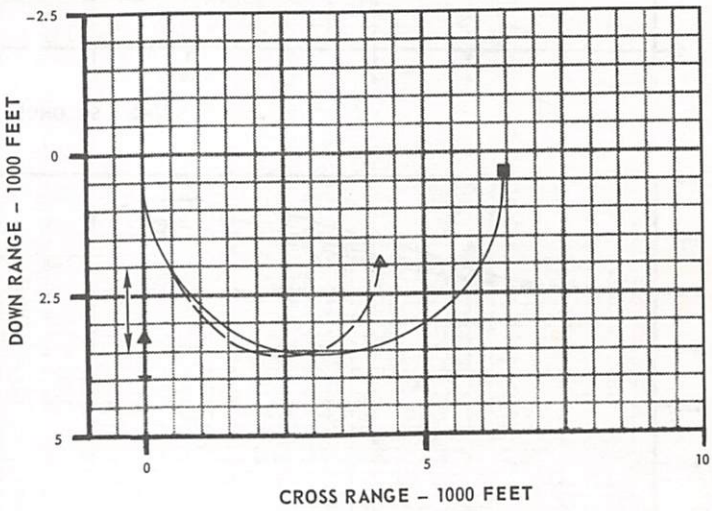
(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

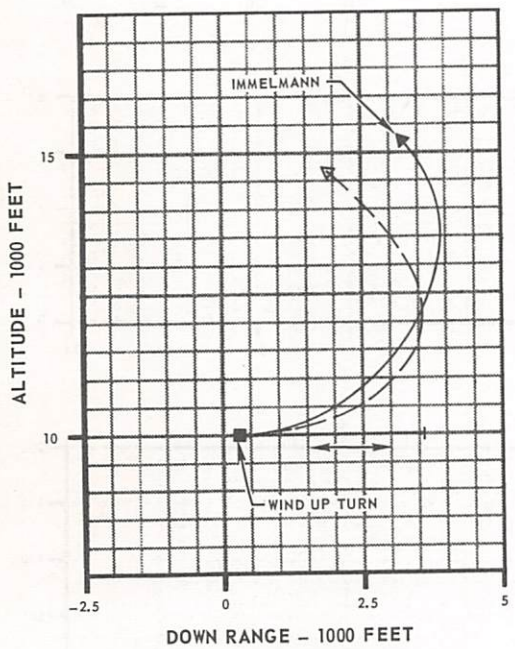
(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

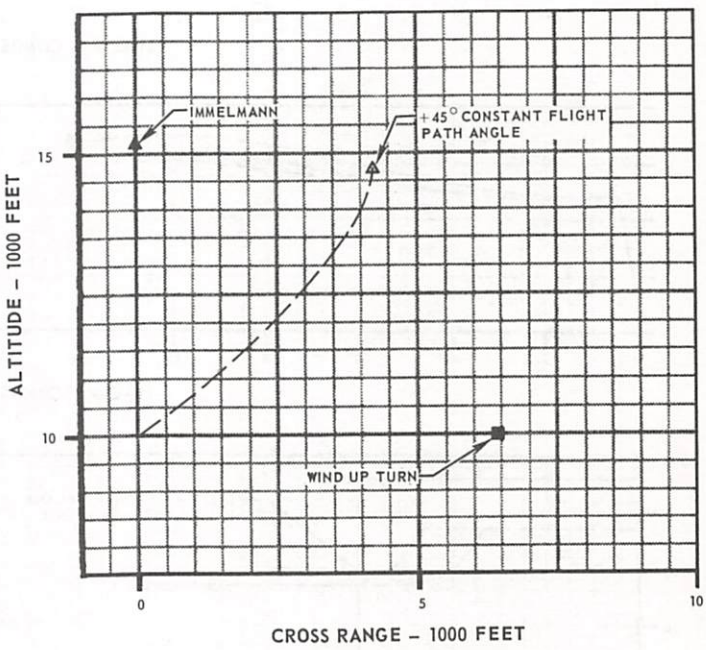
(3) IMMELMANN TURN STOPS AT 135° DUE TO MINIMUM ENGINE SPEED LIMIT.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 350 KCAS









UNCLASSIFIED

FDB-1T-(52-3)

Figure 1-43 (U) (Sheet 3 of 24)

TIME HISTORIES

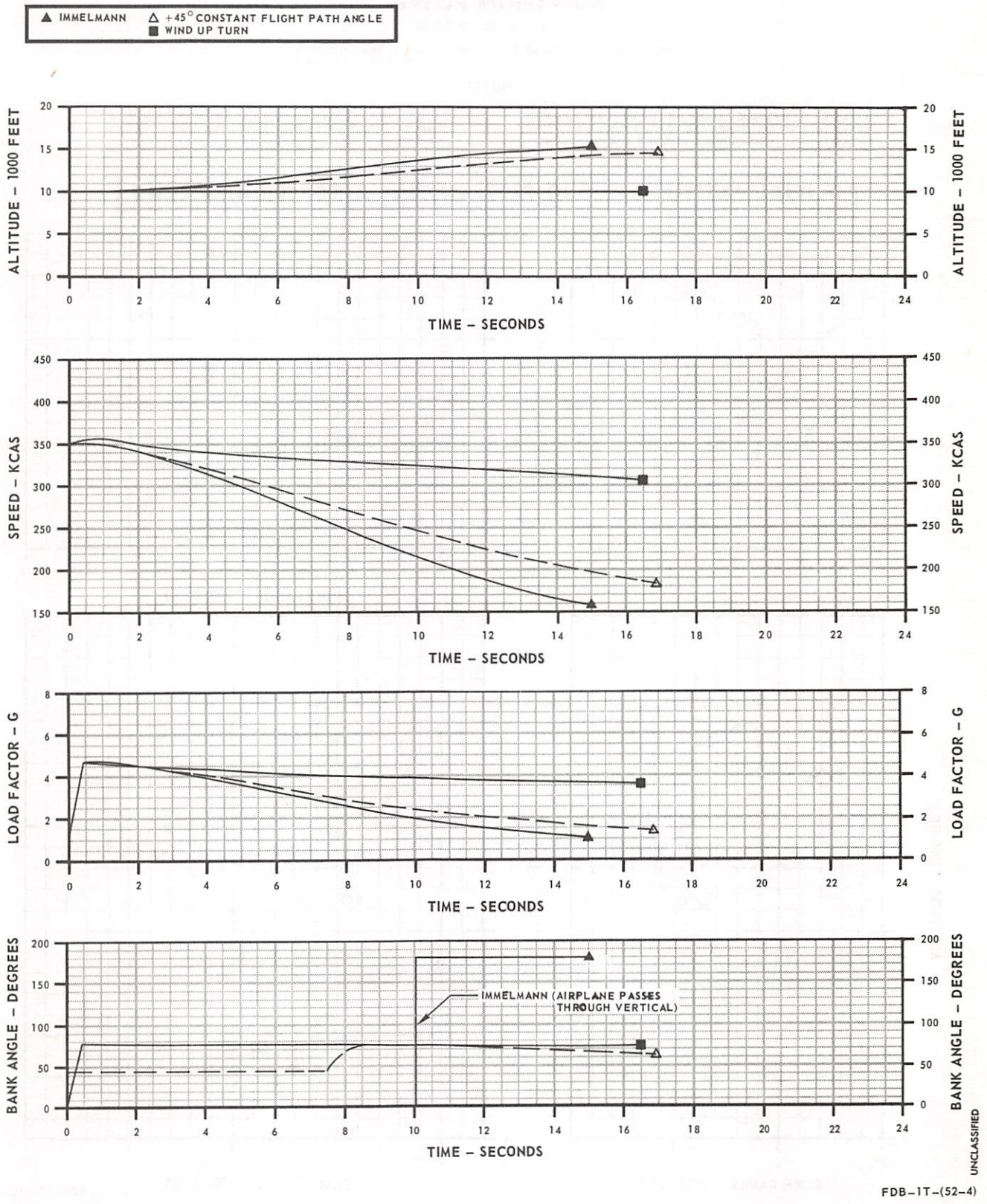


Figure 1-43 (U) (Sheet 4 of 24)

HEADING REVERSALS

DIVING TURNS
GROSS WEIGHT – 37,500 POUNDS
MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FT
19 UNITS ABOVE 15,000 FT

NOTES

(1) LOAD FACTOR AT TIME ZERO IS 1.0 G. LOAD FACTOR INCREASES AT 8.5 G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 450 KCAS

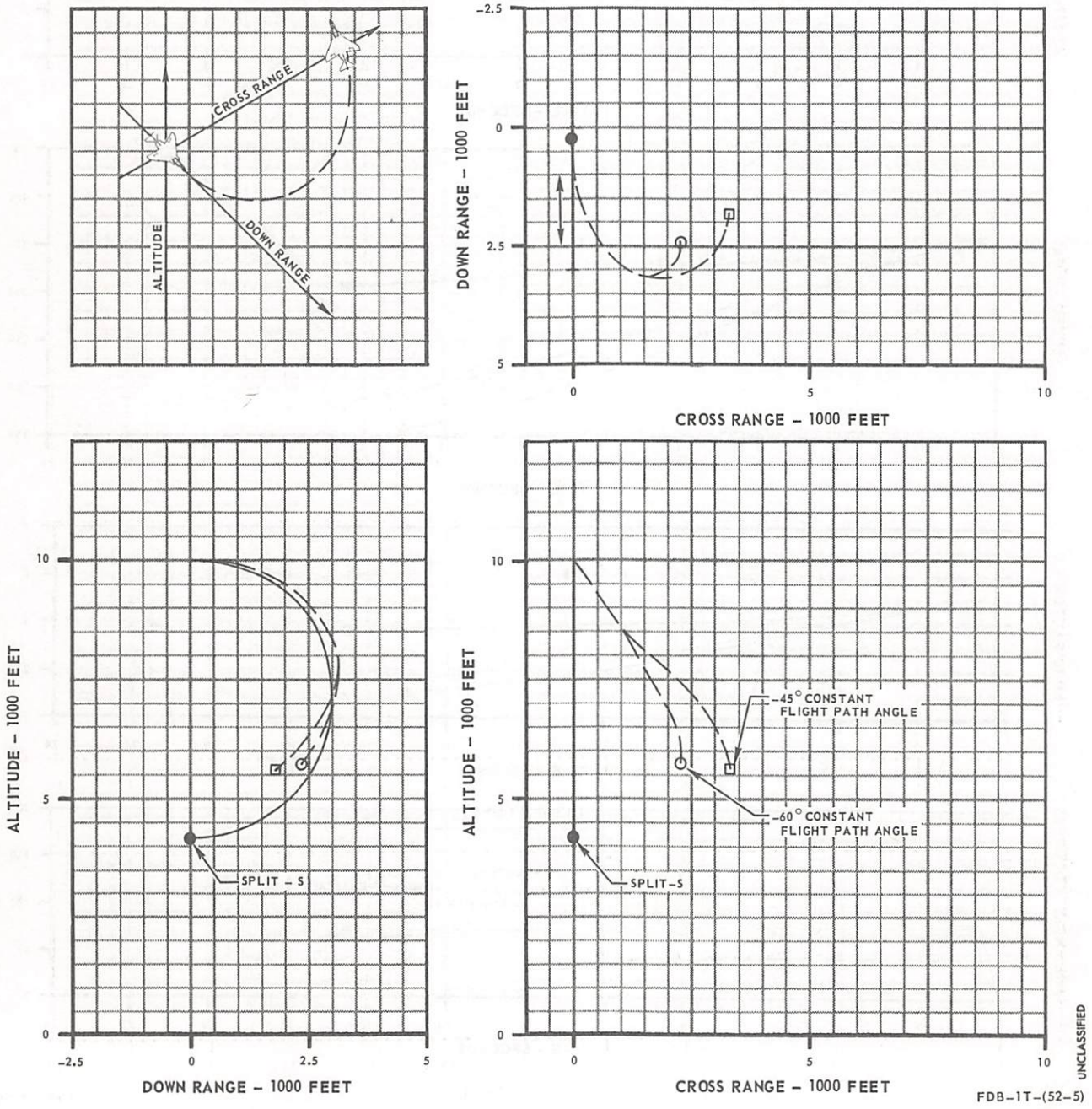


Figure 1-43 (U) (Sheet 5 of 24)

TIME HISTORIES

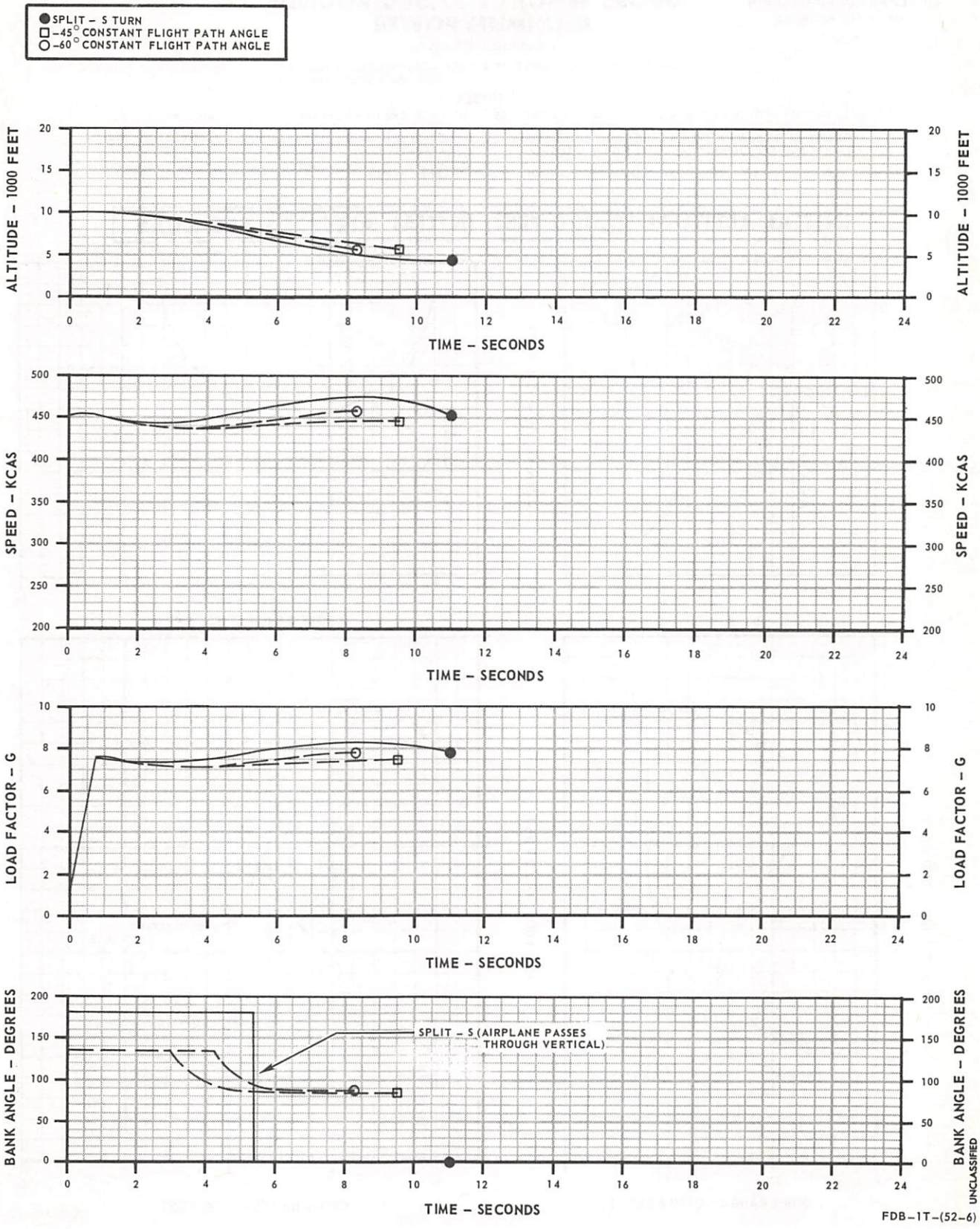


Figure 1-43 (U) (Sheet 6 of 24)

HEADING REVERSALS
LEVEL/CLIMBING TURNS
GROSS WEIGHT - 37,500 POUNDS
MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK - 20 UNITS BELOW 15,000 FT
19 UNITS ABOVE 15,000 FT

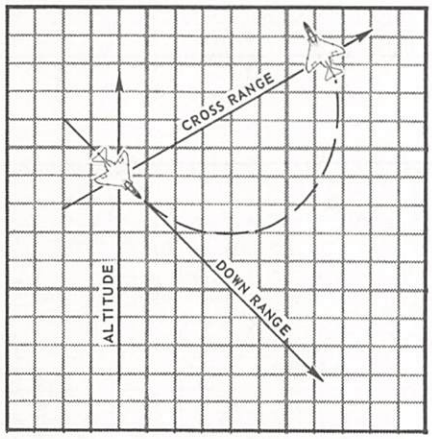
NOTES

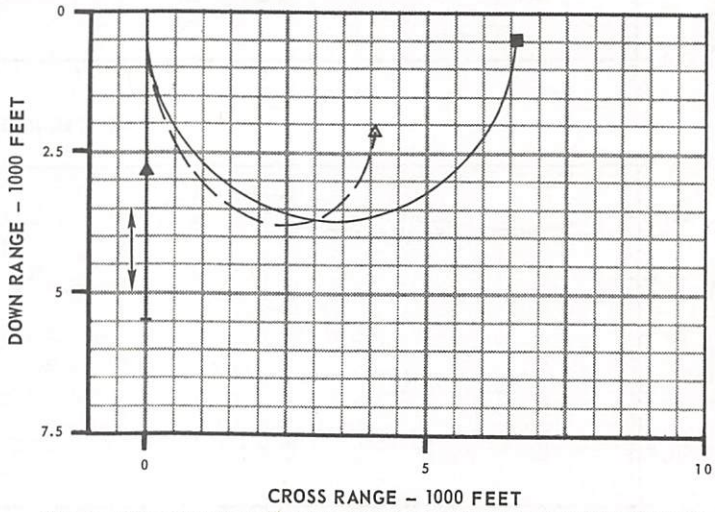
(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

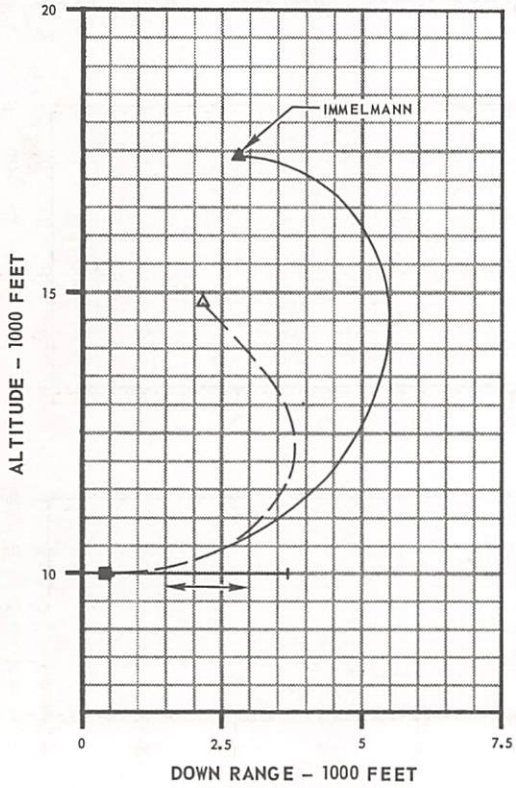
(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

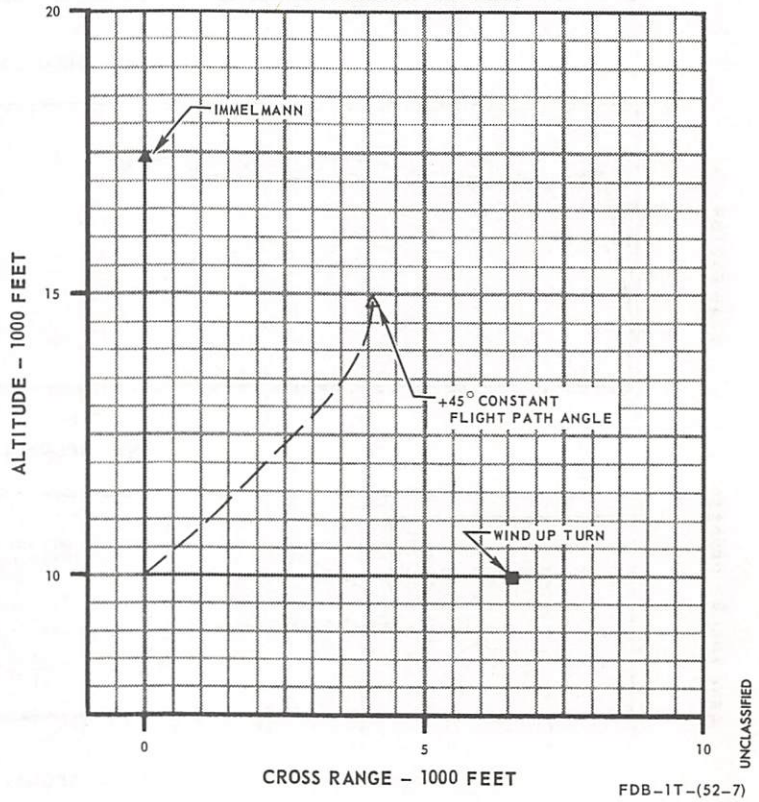
(3) IMMELMANN TURN IS LIMITED TO A 5G PULL UP TO MINIMIZE SPEED DECAY.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 450 KCAS









UNCLASSIFIED

FDB-1T-(52-7)

Figure 1-43 (U) (Sheet 7 of 24)

TIME HISTORIES

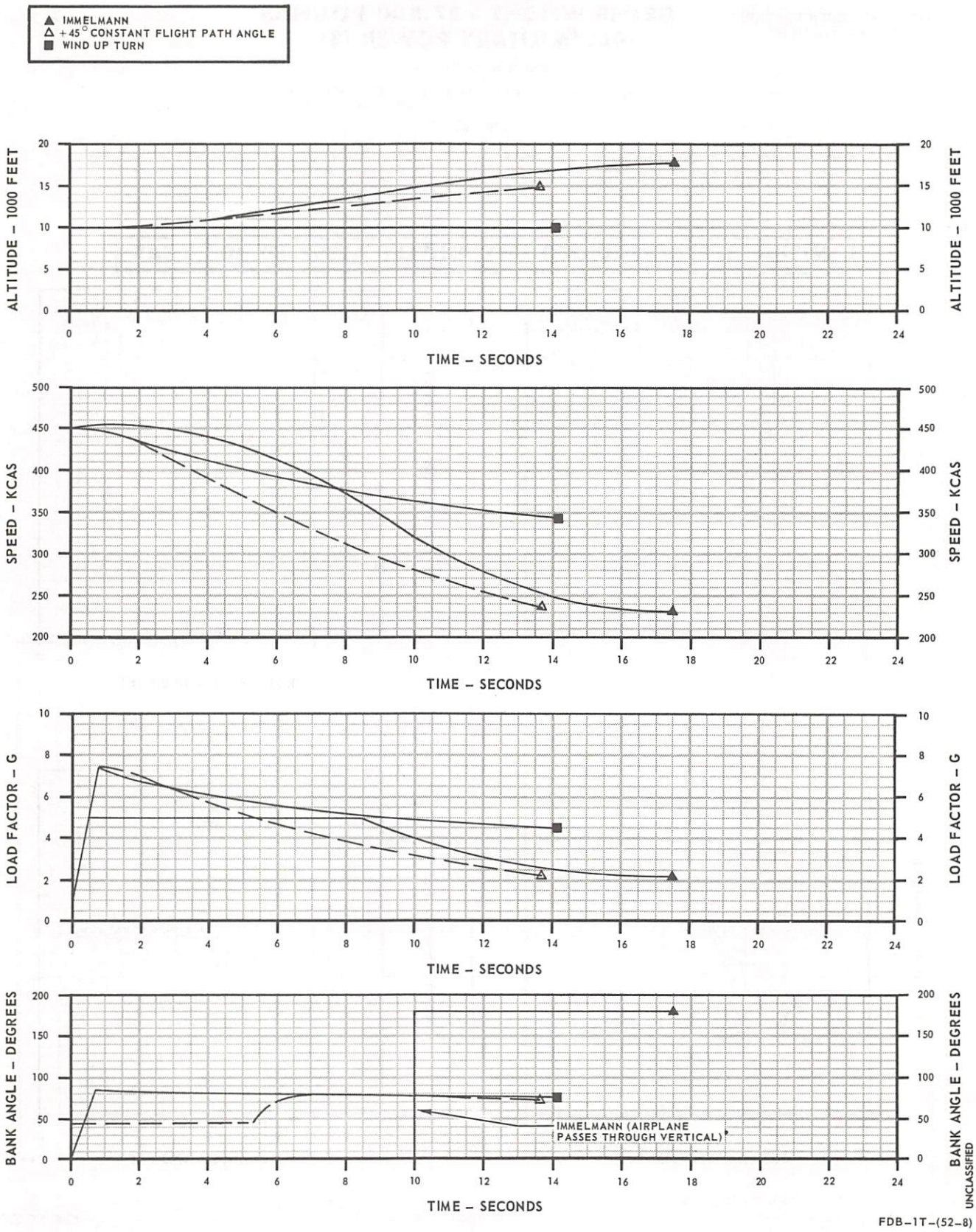


Figure 1-43 (U) (Sheet 8 of 24)

HEADING REVERSALS

DIVING TURNS

GROSS WEIGHT - 37,500 POUNDS

IDLE/MILITARY POWER (3)

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FT
19 UNITS ABOVE 15,000 FT

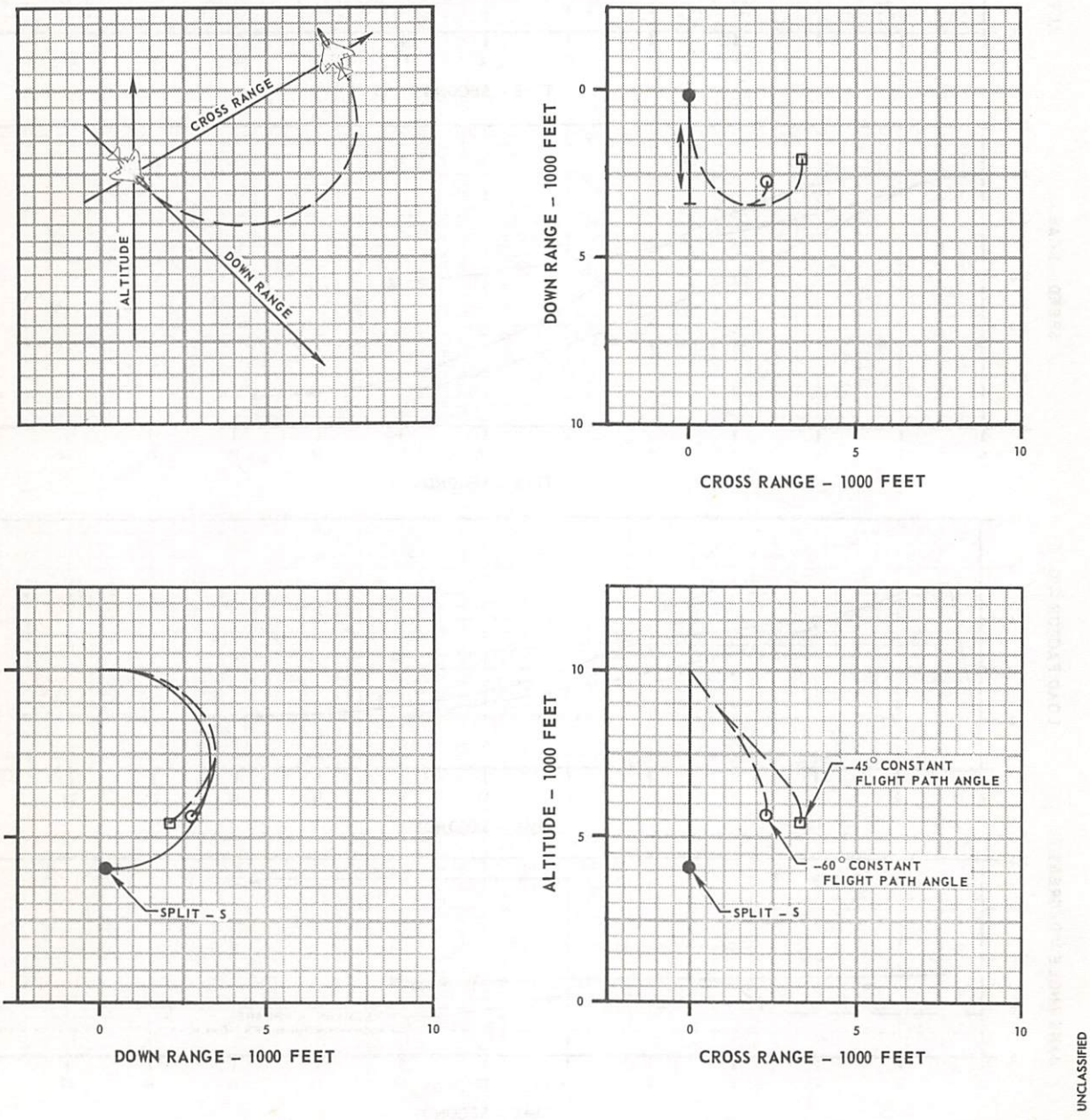
NOTES

(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK OR STRUCTURAL LIMIT MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

(3) IDLE POWER FOR FIRST 90° OF TURN, MILITARY POWER FOR REMAINDER.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 500 KCAS



UNCLASSIFIED

FDB-1T-(52-9)

Figure 1-43 (U) (Sheet 9 of 24)

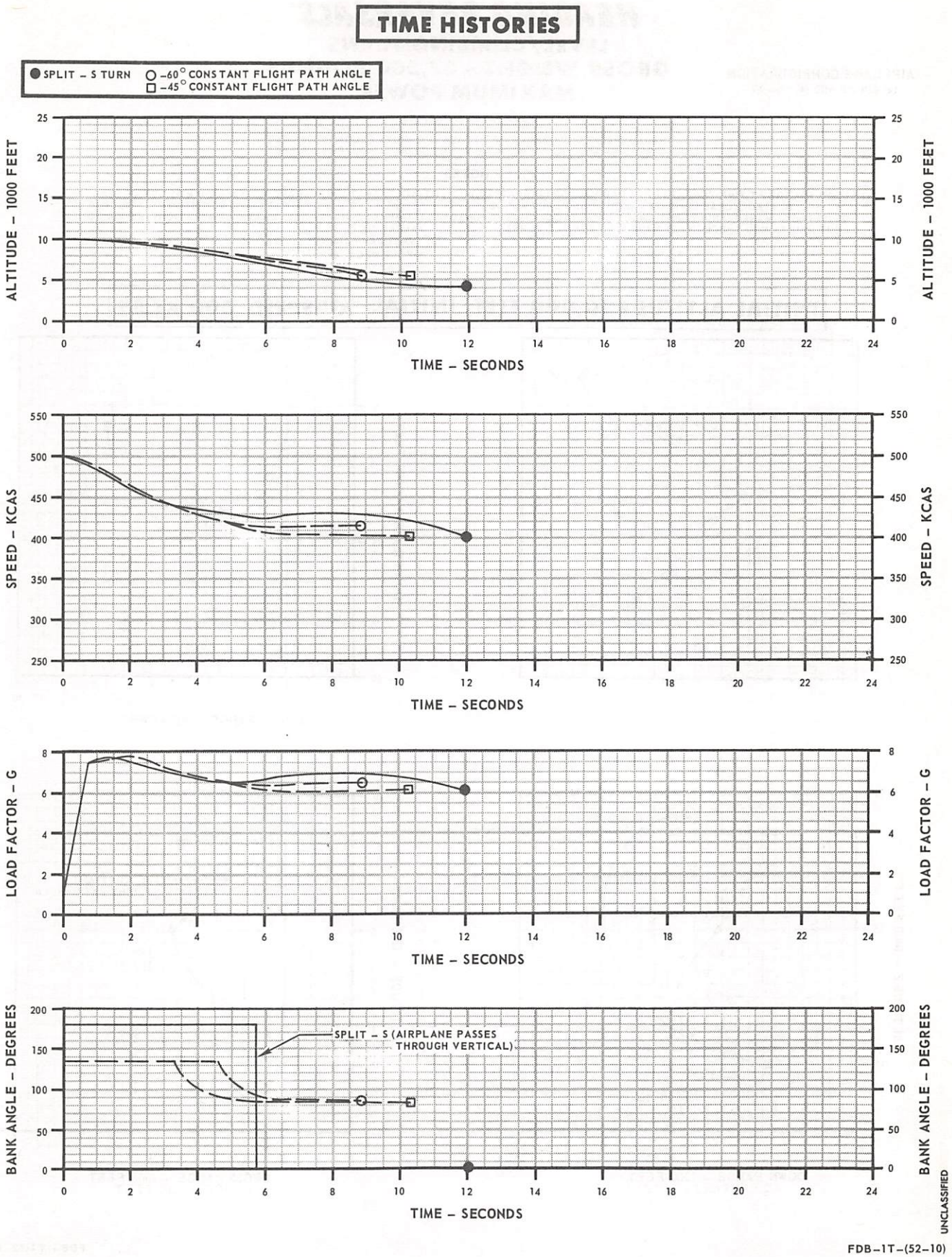


Figure 1-43 (U) (Sheet 10 of 24)

HEADING REVERSALS

LEVEL/CLIMBING TURNS
GROSS WEIGHT - 37,500 POUNDS
MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

(2) J79-GE-10 ENGINES

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

NOTES

(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK OR STRUCTURAL LIMIT MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

(3) IMMELMANN TURN IS LIMITED TO A 5G PULL UP TO MINIMIZE SPEED DECAY.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 500 KCAS

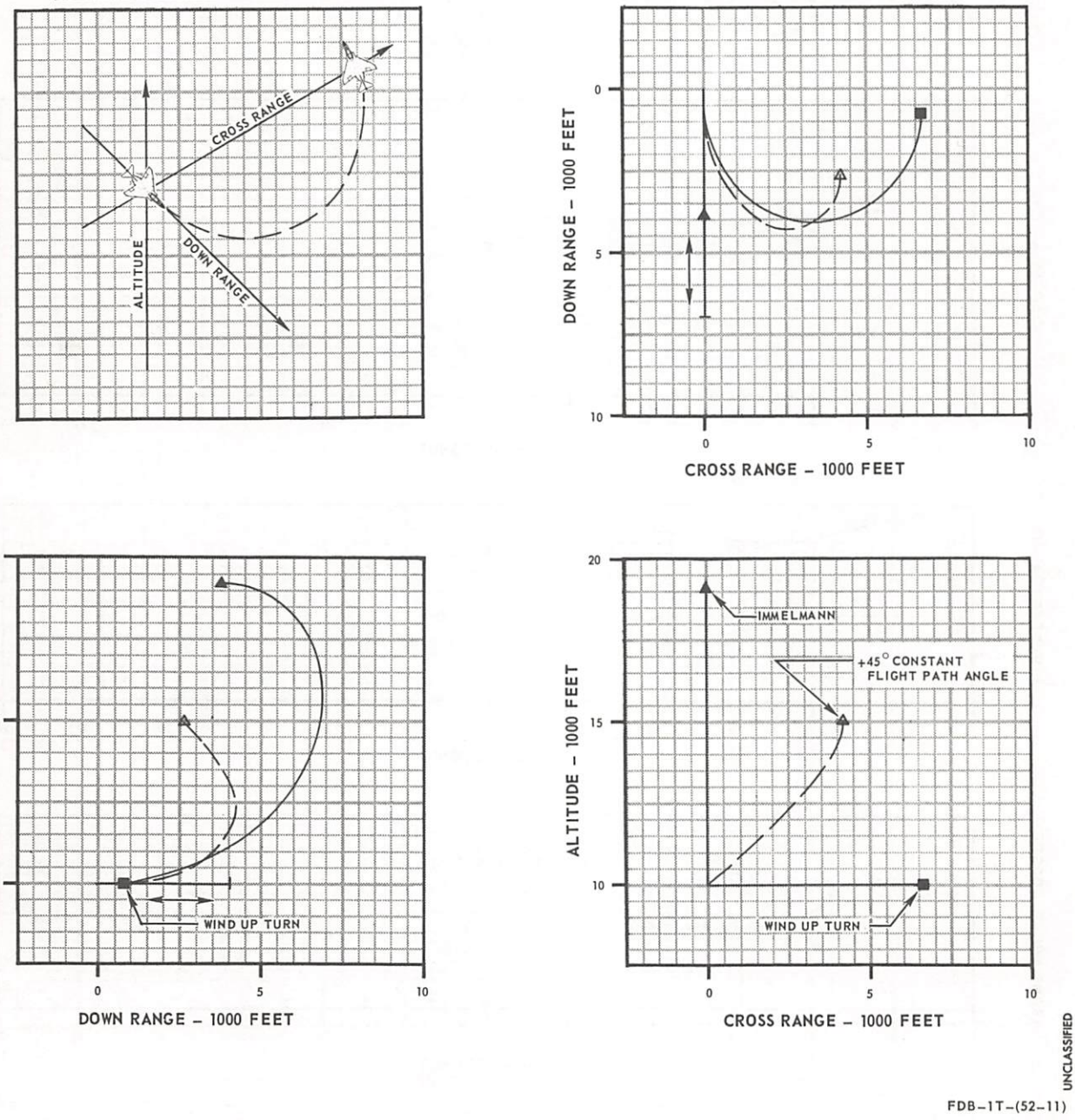


Figure 1-43 (U) (Sheet 11 of 24)

TIME HISTORIES

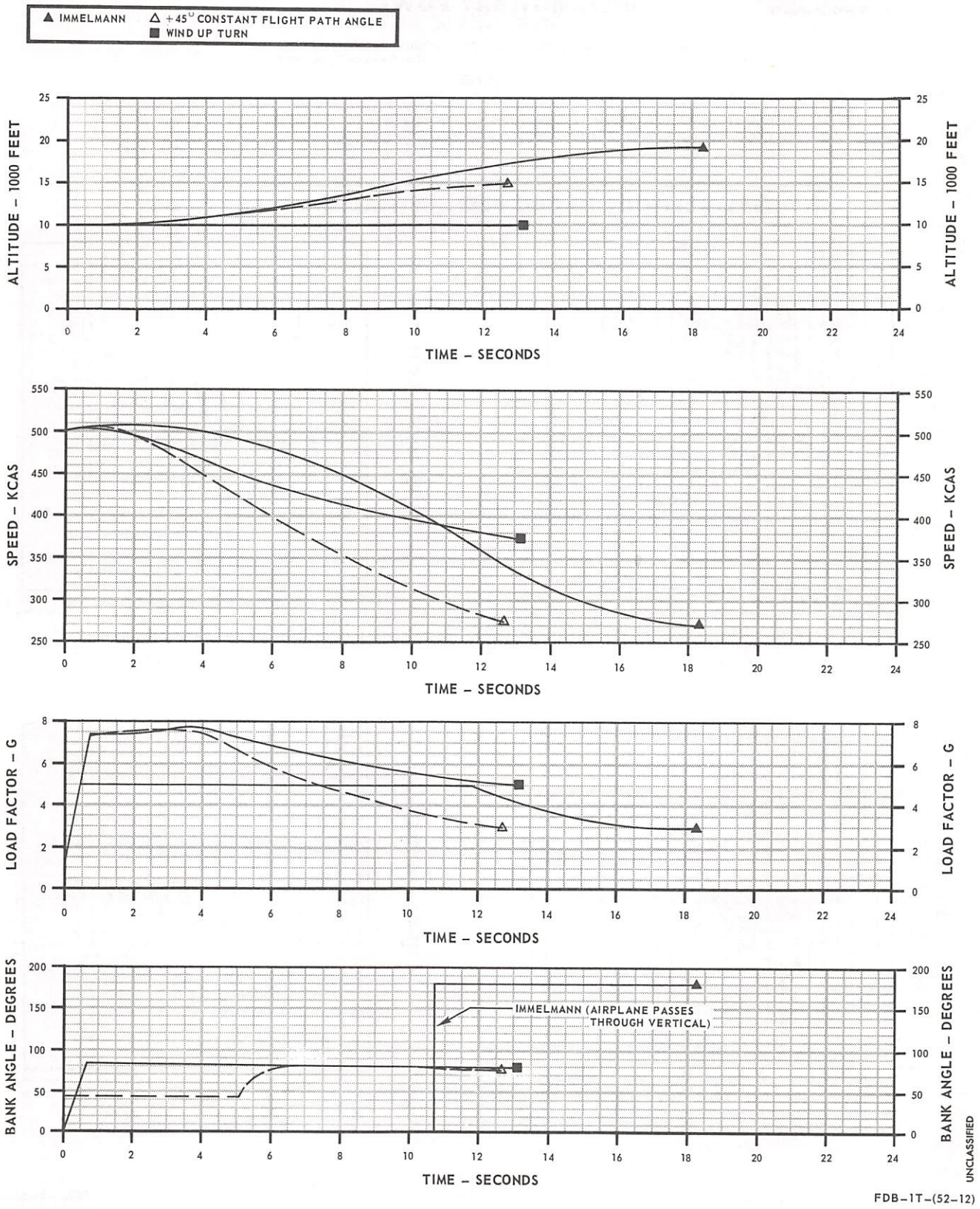


Figure 1-43 (U) (Sheet 12 of 24)

HEADING REVERSALS
LEVEL/DIVING TURNS
GROSS WEIGHT 37,500 POUNDS
IDLE/MILITARY POWER (3)

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

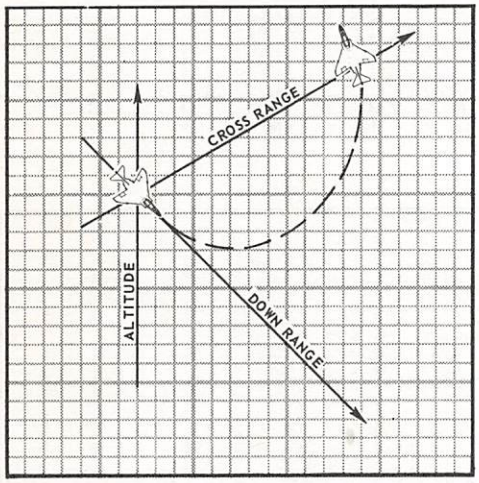
NOTES

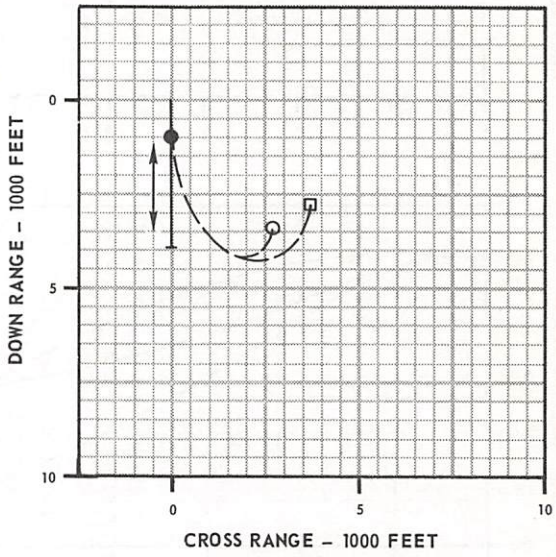
(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK OR STRUCTURAL LIMIT MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

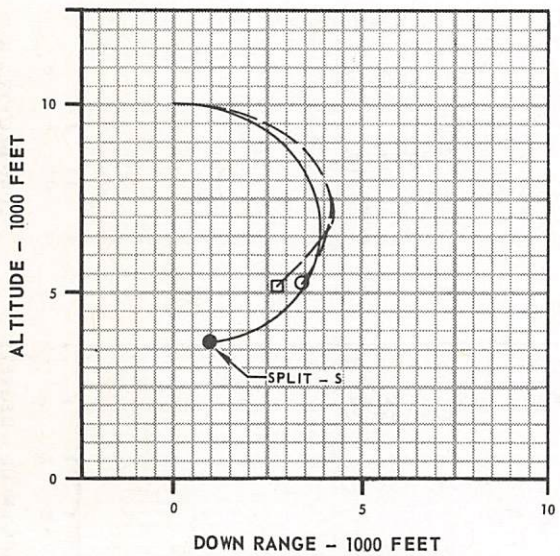
(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

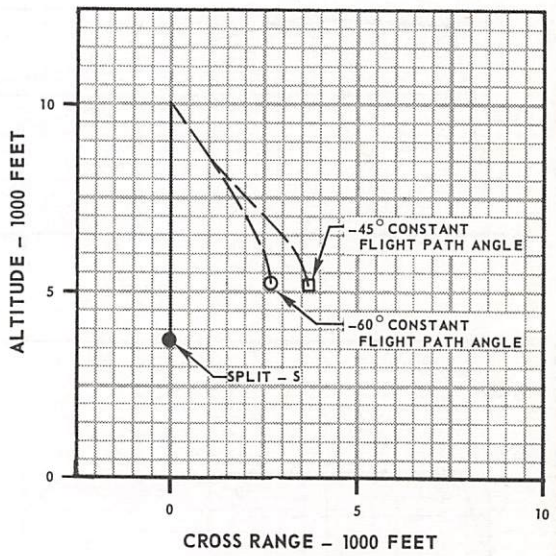
(3) IDLE POWER FOR FIRST 90° OF TURN, MILITARY POWER FOR REMAINDER.

INITIAL ALTITUDE 10,000 FEET, INITIAL SPEED 550 KCAS









UNCLASSIFIED

FDB-1T-(52-13)

Figure 1-43 (U) (Sheet 13 of 24)

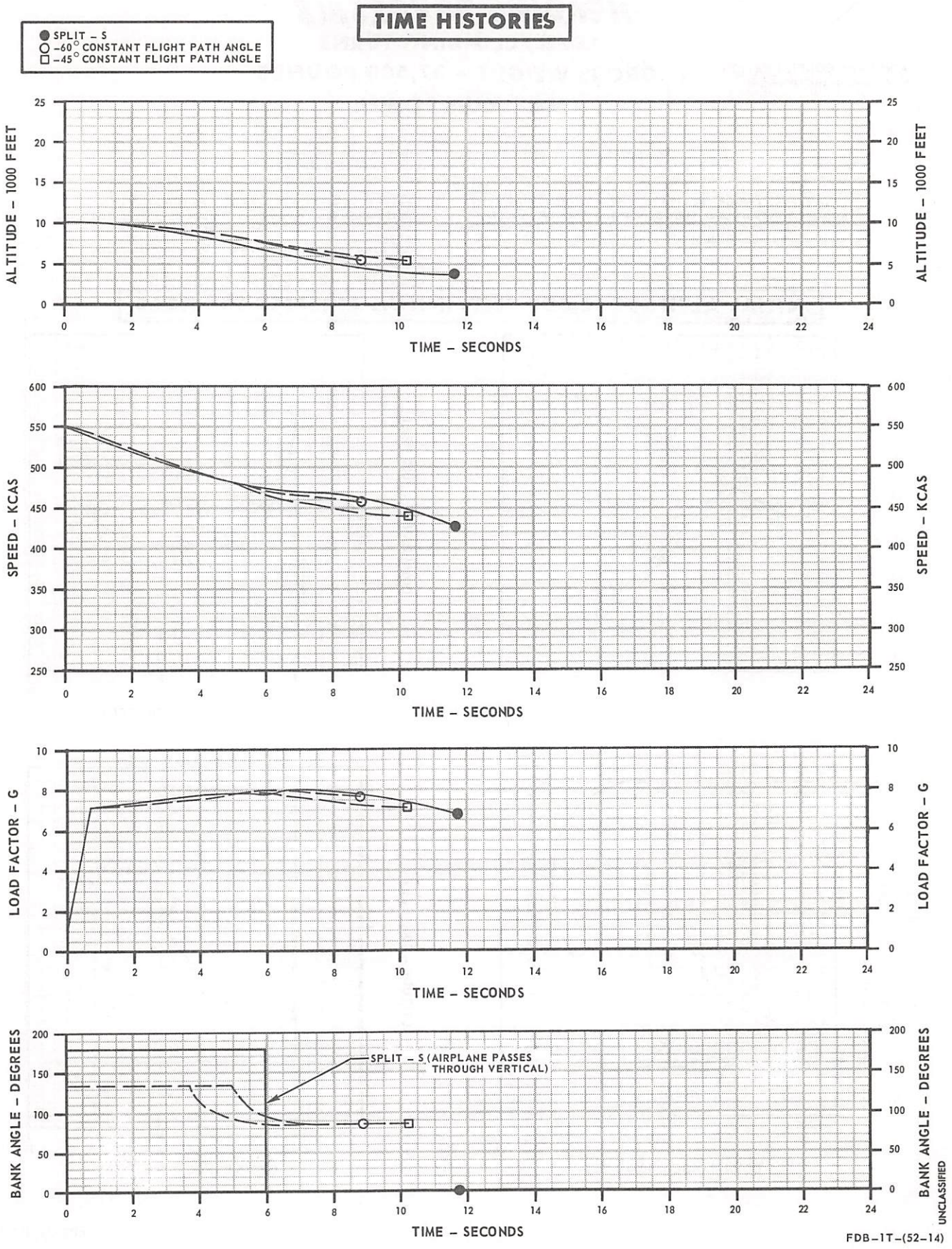


Figure 1-43 (U) (Sheet 14 of 24)

HEADING REVERSALS

LEVEL/CLIMBING TURNS

GROSS WEIGHT – 37,500 POUNDS

MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM–7E AND (4) AIM–9D

ENGINES: (2) J79–GE –10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

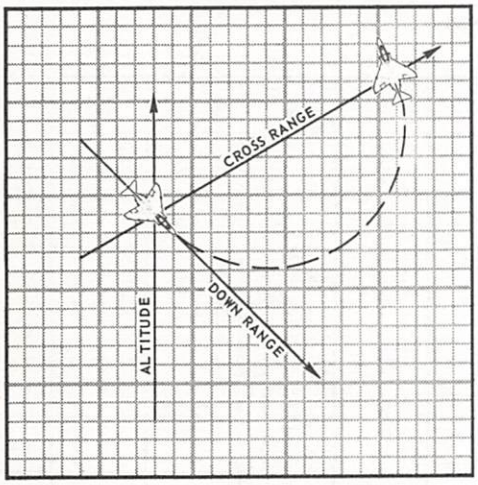
NOTES

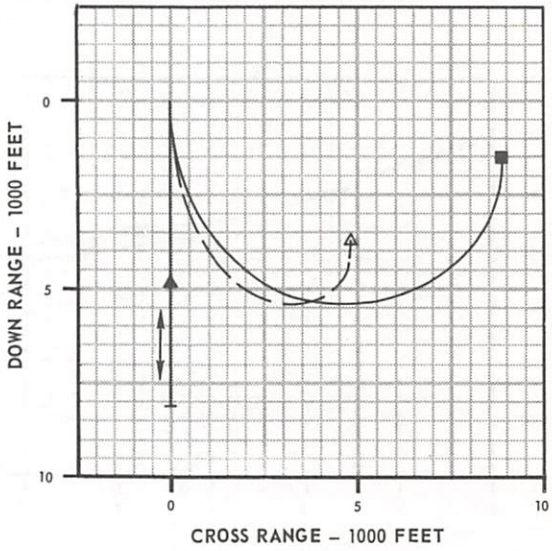
(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK OR STRUCTURAL LIMIT MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

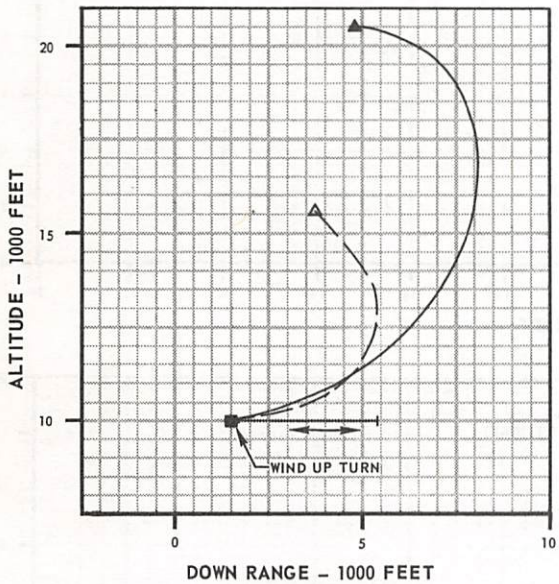
(2) ACCELERATION PLACARD WITH AIM–9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM–9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

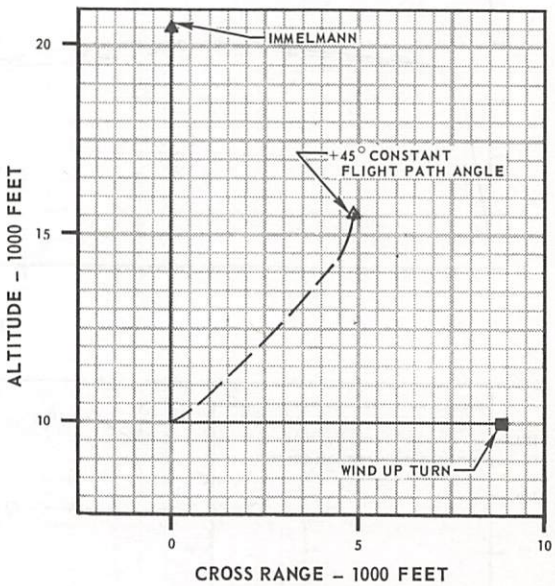
(3) IMMELMANN TURN IS LIMITED TO A 5G PULL UP TO MINIMIZE SPEED DECAY.

INITIAL ALTITUDE 10,000 FEET, INITIAL AIRSPEED 550 KCAS









UNCLASSIFIED

FDB–1T–(52–15)

Figure 1-43 (U) (Sheet 15 of 24)

TIME HISTORIES

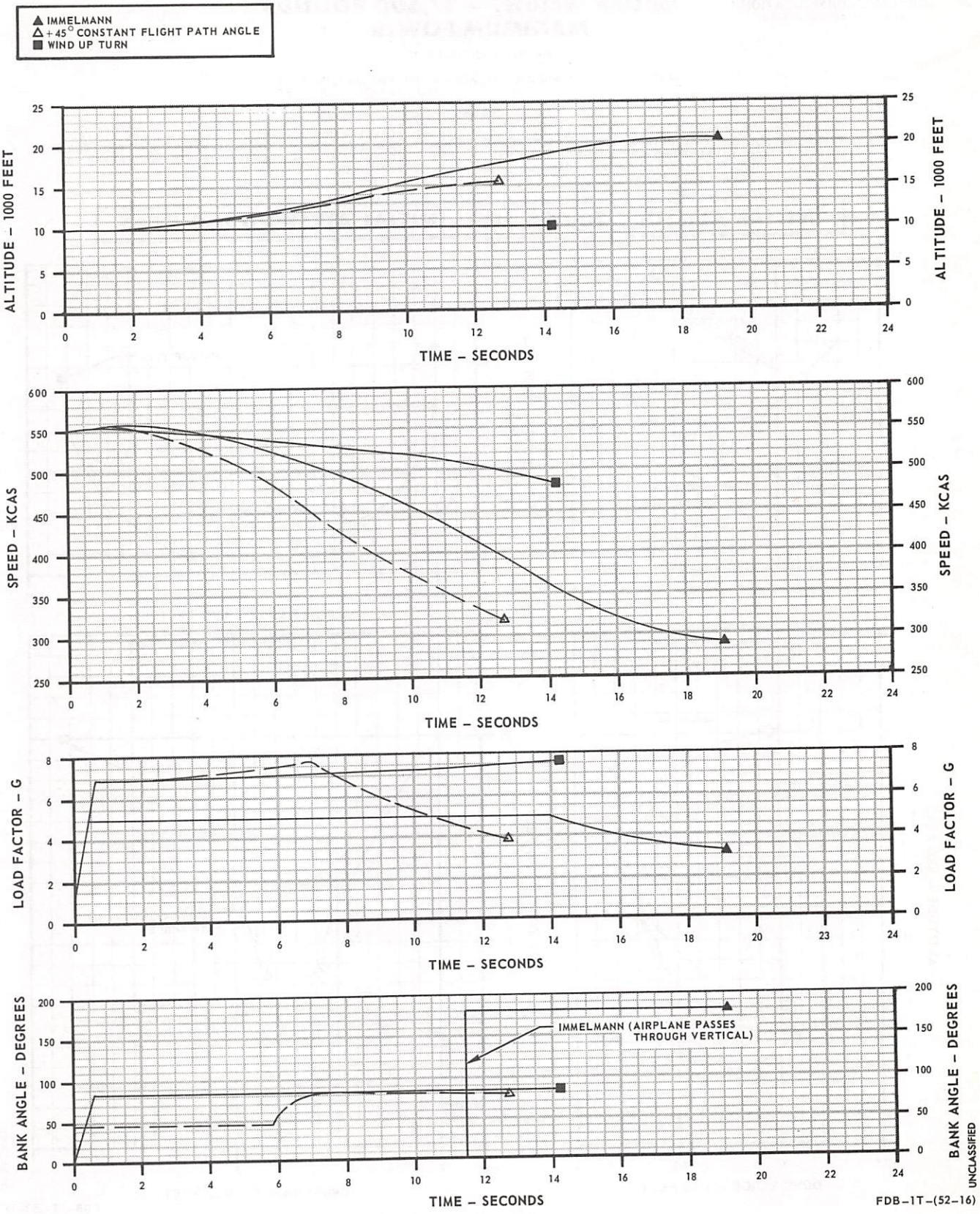


Figure 1-43 (U) (Sheet 16 of 24)

HEADING REVERSALS

LEVEL/DIVING TURNS
GROSS WEIGHT – 37,500 POUNDS
MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

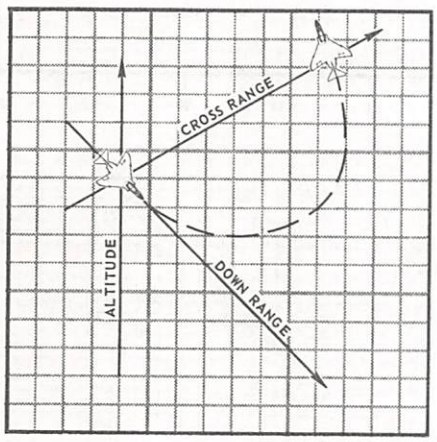
MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

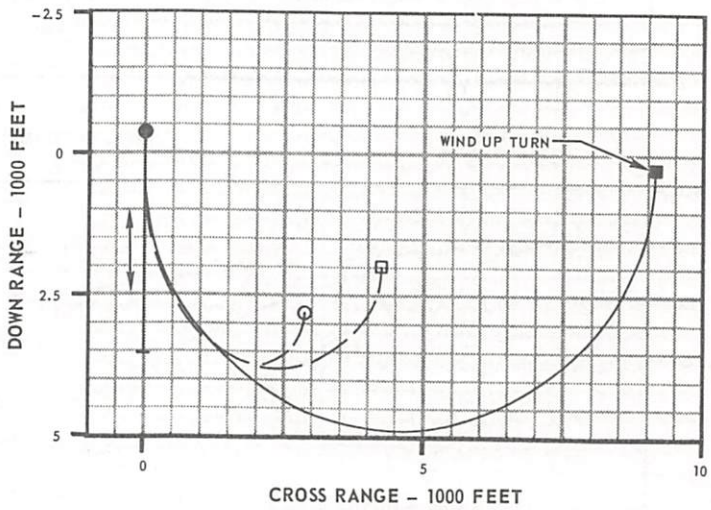
NOTES

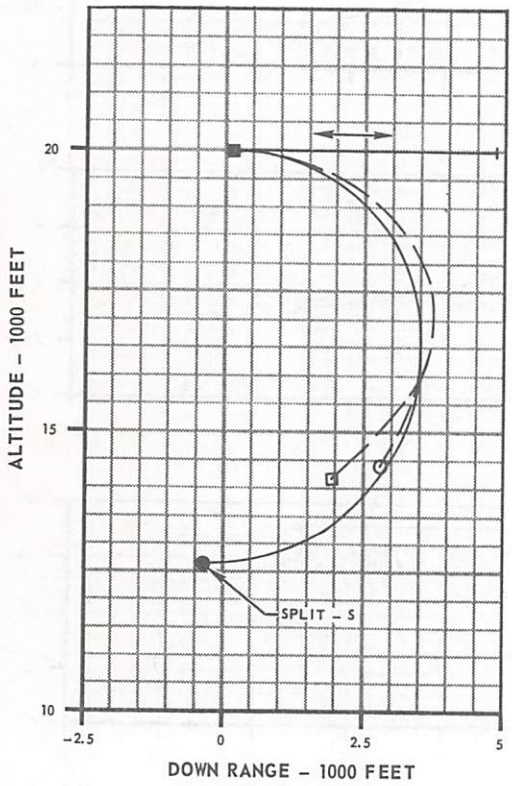
(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

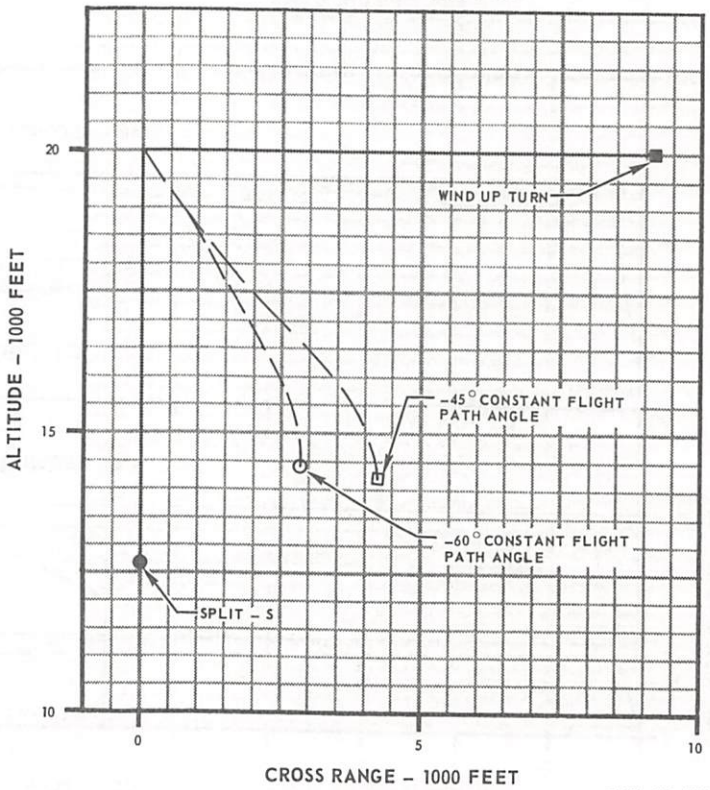
(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATIONS 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

INITIAL ALTITUDE 20,000 FEET, INITIAL AIRSPEED 350 KCAS









UNCLASSIFIED

FDB-1T-(52-17)

Figure 1-43 (U) (Sheet 17 of 24)

TIME HISTORIES

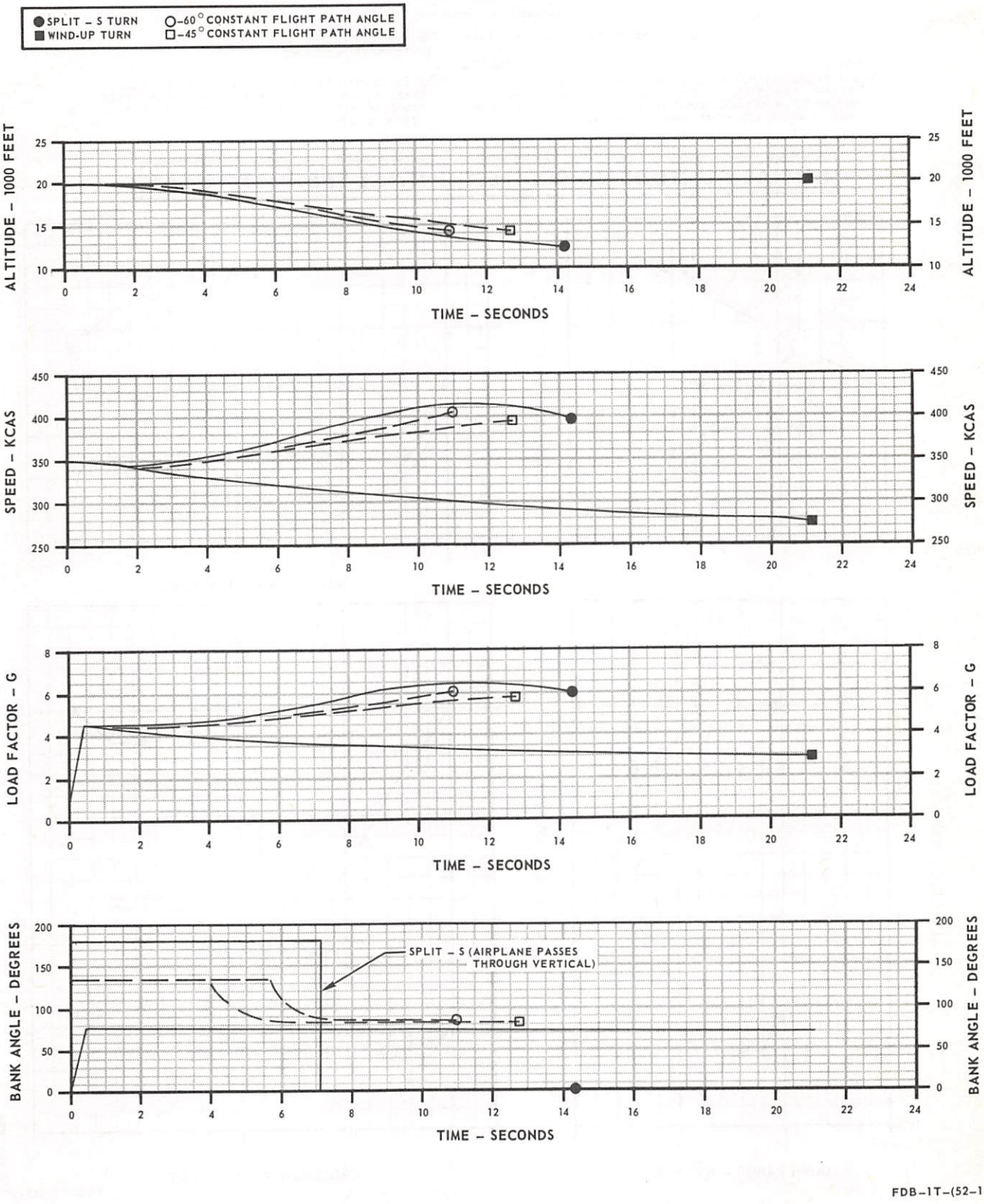


Figure 1-43 (U) (Sheet 18 of 24)

HEADING REVERSALS

LEVEL/DIVING TURNS
GROSS WEIGHT - 37,500 POUNDS
MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK - 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

NOTES

(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

INITIAL ALTITUDE 20,000 FEET, INITIAL SPEED 450 KCAS

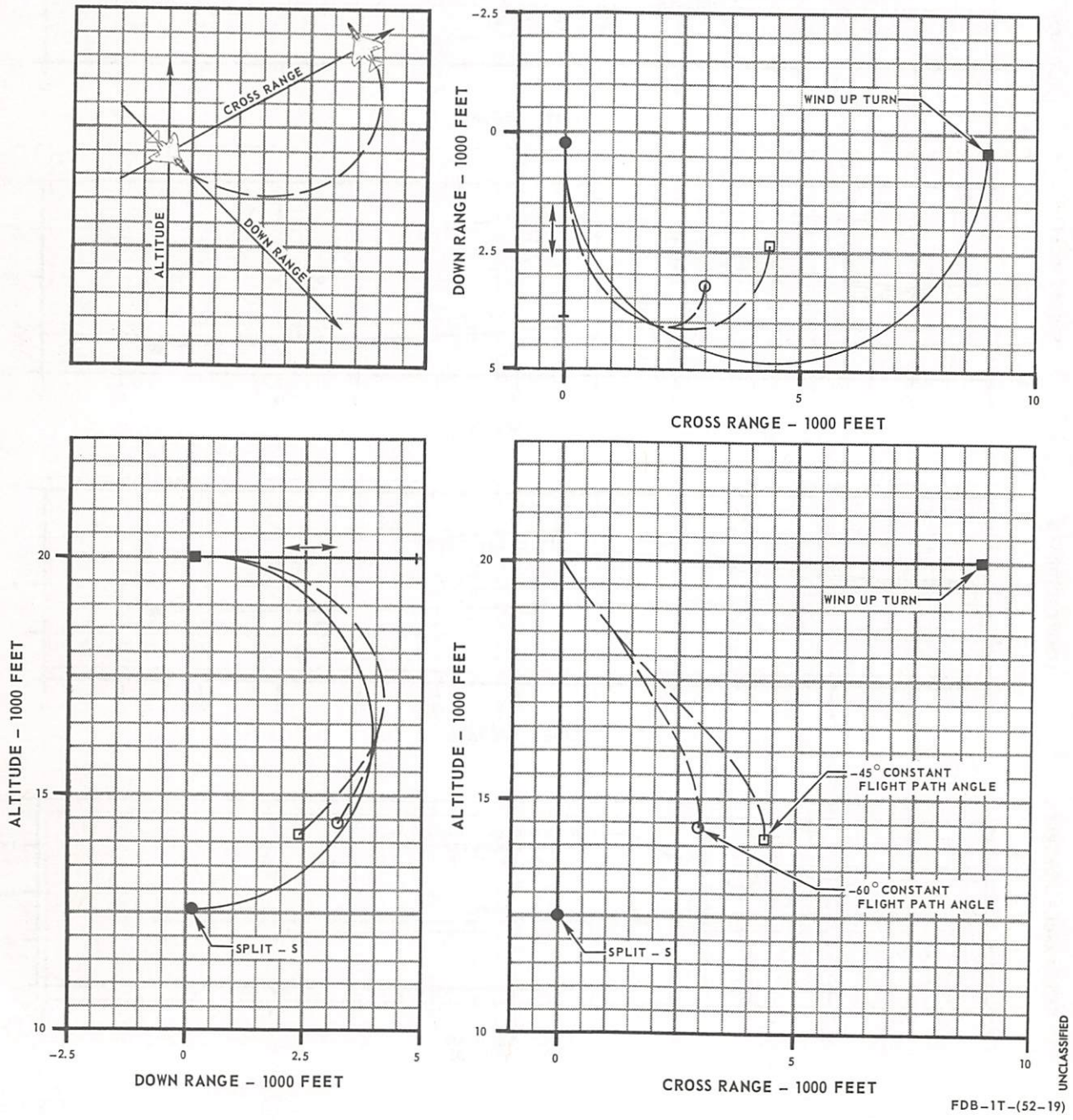


Figure 1-43 (U) (Sheet 19 of 24)

TIME HISTORIES

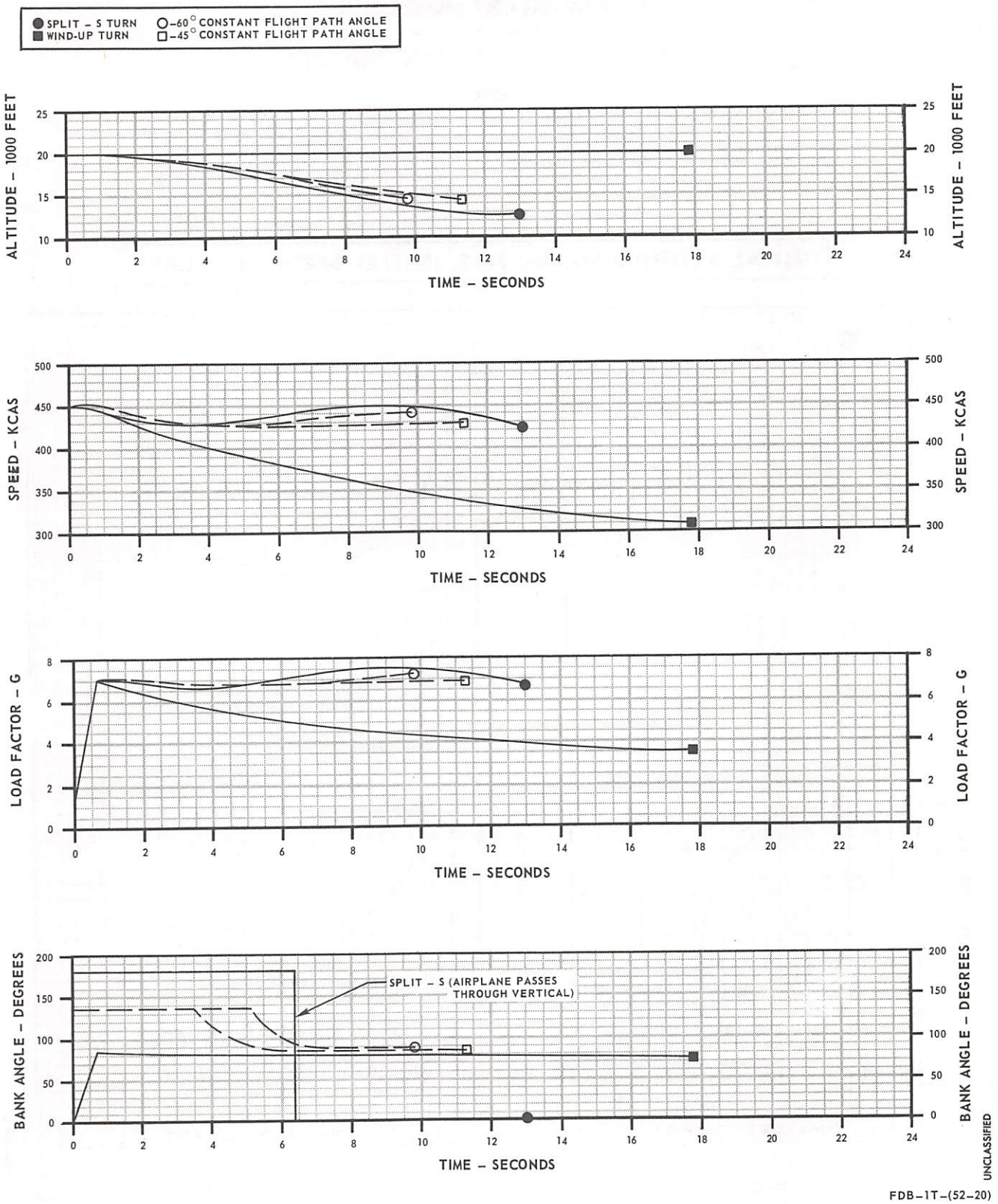


Figure 1-43 (U) (Sheet 20 of 24)

HEADING REVERSALS

LEVEL/DIVING TURNS
GROSS WEIGHT 37,500 POUNDS
IDLE/MILITARY POWER (3)

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

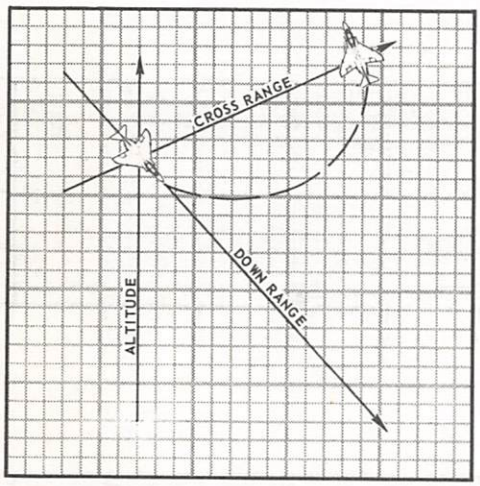
NOTES

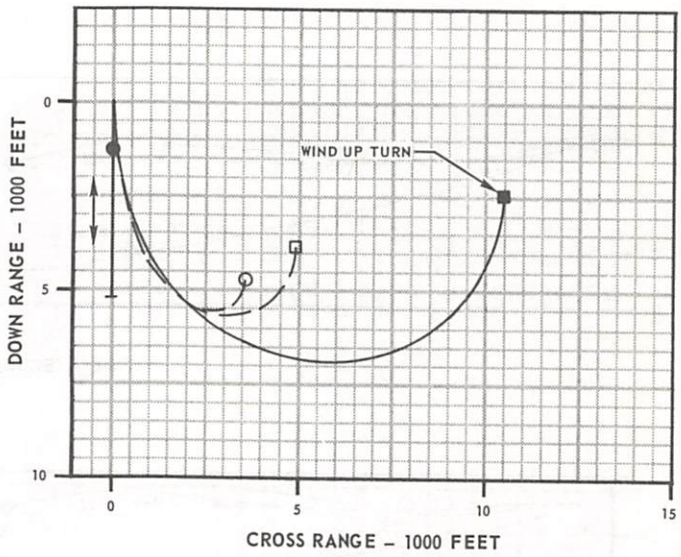
(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK OR STRUCTURAL LIMIT MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

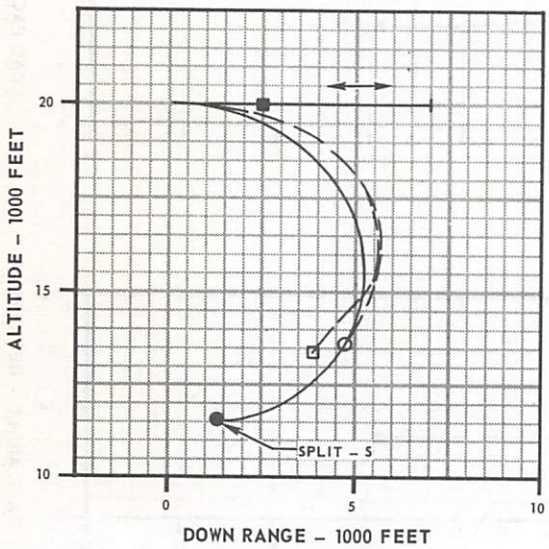
(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

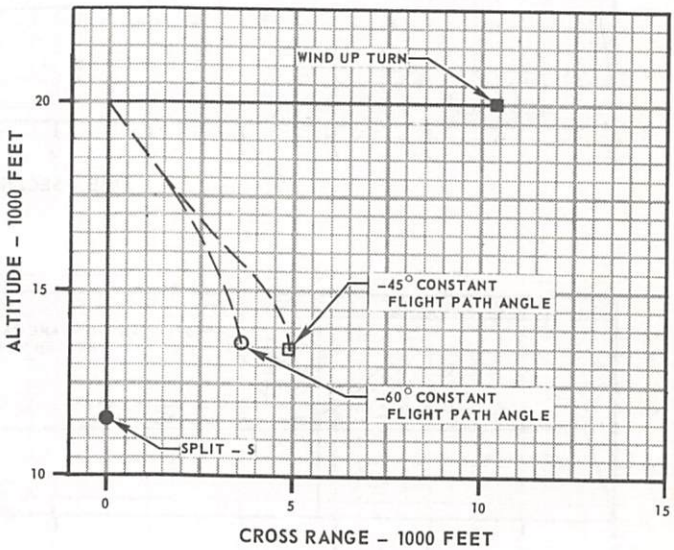
(3) WIND UP TURN AT MAXIMUM POWER, REMAINING TURNS AT IDLE POWER FOR FIRST 90° OF TURN, MILITARY POWER OR REMAINDER.

INITIAL ALTITUDE 20,000 FEET, INITIAL SPEED 550 KCAS









UNCLASSIFIED

FDB-1T-(52-21)

Figure 1-43 (U) (Sheet 21 of 24)

TIME HISTORIES

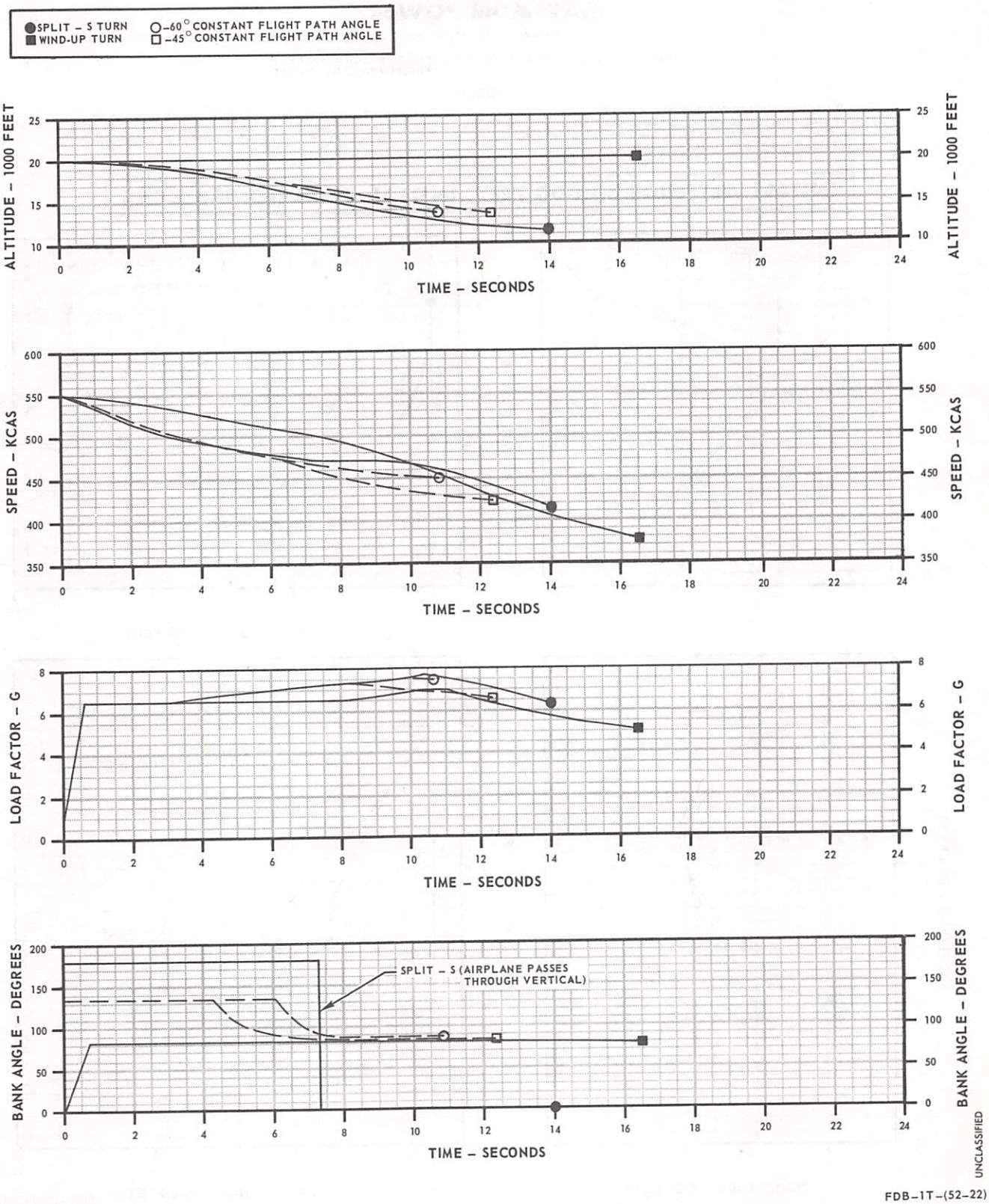


Figure 1-43 (U) (Sheet 22 of 24)

HEADING REVERSALS

LEVEL/DIVING TURNS

GROSS WEIGHT 37,500 POUNDS

MAXIMUM POWER

AIRPLANE CONFIGURATION
(4) AIM-7E AND (4) AIM-9D

ENGINE(S): (2) J79-GE-10

MANEUVERING LIMIT ANGLE OF ATTACK – 20 UNITS BELOW 15,000 FEET
19 UNITS ABOVE 15,000 FEET

NOTES

(1) LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC TO STRUCTURAL LIMIT OR MANEUVERING LIMIT ANGLE OF ATTACK. MANEUVERING LIMIT ANGLE OF ATTACK IS MAINTAINED THROUGHOUT MANEUVER FOR ALL TURNS.

(2) ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

INITIAL ALTITUDE 30,000 FEET, INITIAL AIRSPEED 350 KCAS

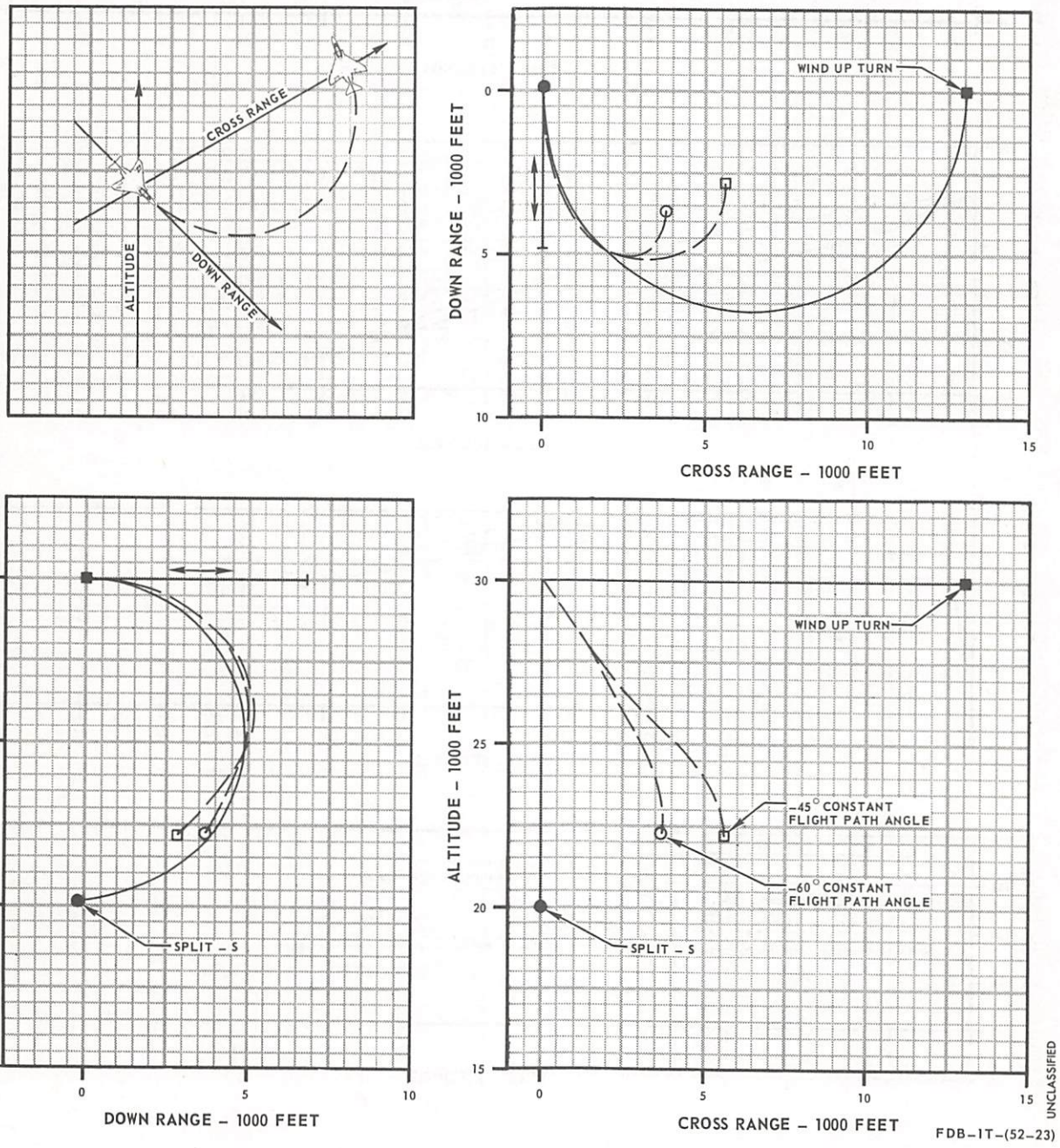


Figure 1-43 (U) (Sheet 23 of 24)

TIME HISTORIES

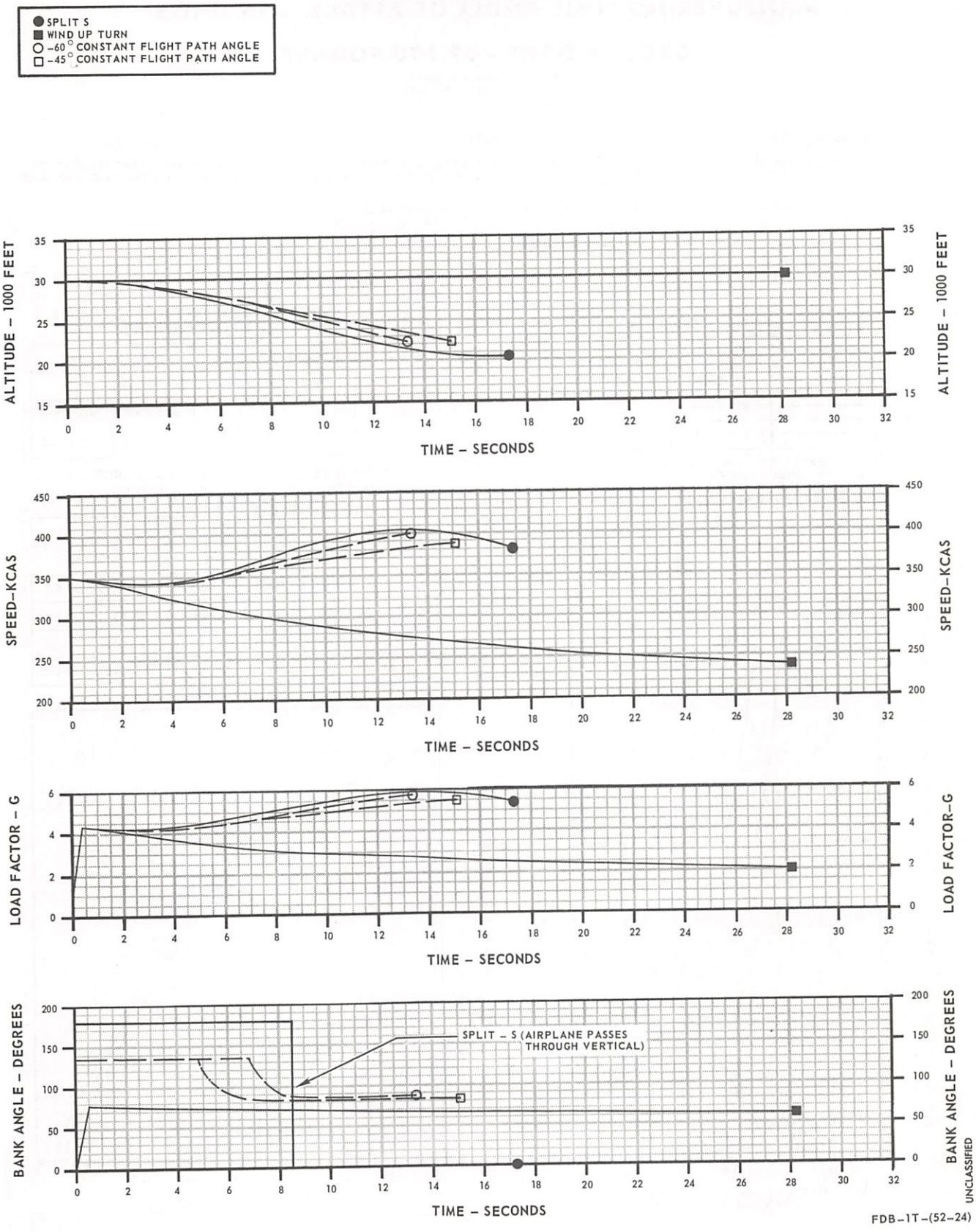


Figure 1-43 (U) (Sheet 24 of 24)

SPLIT-S MANEUVER

MANEUVERING LIMIT ANGLE OF ATTACK - 16 UNITS

GROSS WEIGHT - 37,500 POUNDS

F4B (2) J79-GE-8 ENGINES
F4J (2) J79-GE-10 ENGINES

CONFIGURATION

(4) AIM-7E, AND (4) AIM-9D

NOTES

1. LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC AT ENTRY UNTIL MANEUVERING LIMIT ANGLE OF ATTACK IS REACHED.
2. ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

REMARKS:

DATA SHOWN IS REPRESENTATIVE AND BASED ON THE F-4B AIRPLANE.

	INITIAL SPEED	POWER
— — —	250 KCAS	MIL
———	350 KCAS	MIL
—— ——	450 KCAS	MIL
— — — —	550 KCAS	IDLE *

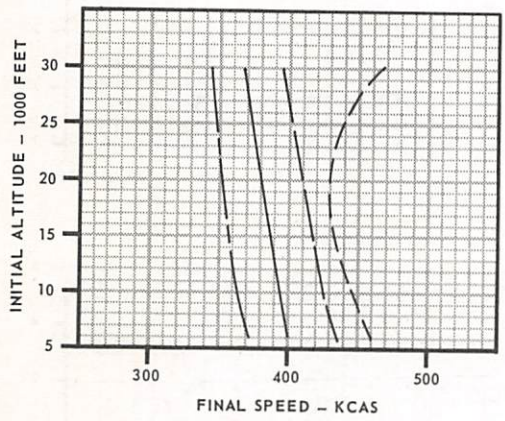
*IDLE POWER UNTIL AIRCRAFT IS VERTICAL. MILITARY POWER FOR REMAINDER OF TURN. (IDLE POWER IS USED FOR SPLIT-S MANEUVERS INITIATED ABOVE 450 KCAS.)

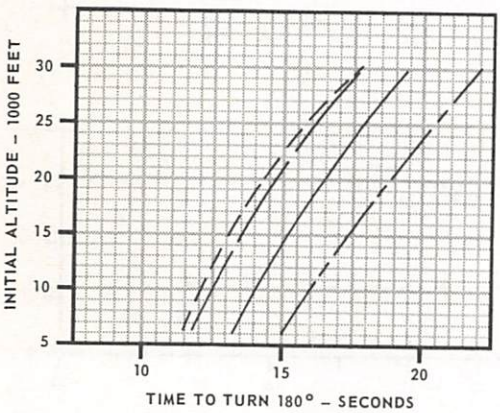
DIFFERENCES ATTRIBUTED TO CHANGE FROM F-4B TO F-4J AIRPLANE.

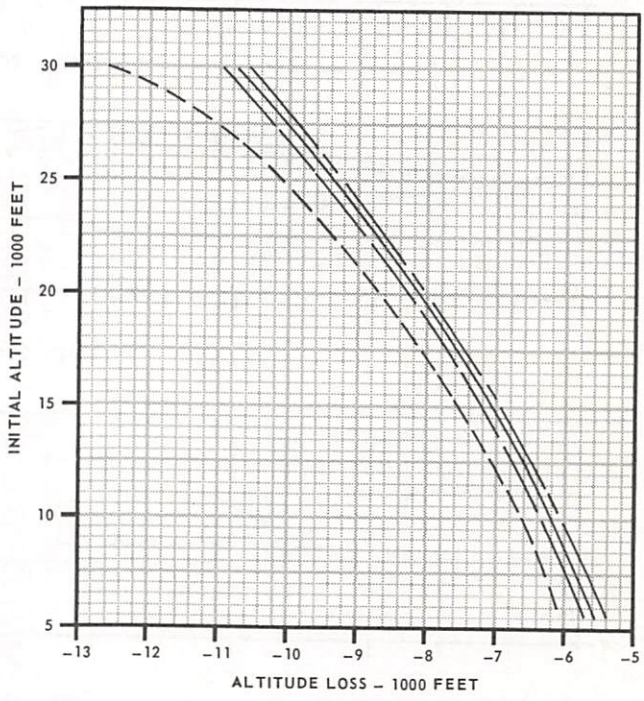
ALTITUDE LOSS	LESS THAT 50 FT	
TIME TO TURN	LESS THAN .5 SEC	
FINAL SPEED	MAX PWR +14 KCAS	MIL PWR +10 KCAS

DIFFERENCES ATTRIBUTED TO CHANGE IN POWER SETTING (350 KCAS AND 450 KCAS INITIAL SPEED ONLY).

	FOR INITIAL ALTITUDE			
	10,000 FT		30,000 FT	
	MAX	IDLE *	MAX	IDLE *
ALTITUDE LOSS	+100 FT	-50 FT	+150 FT	-50 FT
TIME TO TURN	-1 SEC	+1 SEC	-1 SEC	+1 SEC
FINAL SPEED	+55 KCAS	-20 KCAS	+45 KCAS	-15 KCAS







FDB-1T-(53-1)

Figure 1-44 (U) (Sheet 1 of 2)

SPLIT-S MANEUVER

MANEUVERING LIMIT ANGLE OF ATTACK- 20 UNITS BELOW 15,000 FEET 19 UNITS ABOVE 15,000 FEET

GROSS WEIGHT - 37,500 POUNDS

F-4B (2) J79-GE-8 ENGINES
F-4J (2) J79-GE-10 ENGINES

CONFIGURATION

(4) AIM-7E AND (4) AIM-9D

NOTES

1. LOAD FACTOR AT TIME ZERO IS 1.0G. LOAD FACTOR INCREASES AT 8.5G/SEC AT ENTRY UNTIL MANEUVERING LIMIT ANGLE OF ATTACK IS REACHED.
2. ACCELERATION PLACARD WITH AIM-9D MISSILES AT STATION 2 AND 8 IS 6.0 G FOR GROSS WEIGHT DEPICTED. FOR COMPLETE AIM-9 ACCELERATION LIMITATIONS, REFER TO APPENDIX I.

REMARKS:

DATA SHOWN IS REPRESENTATIVE AND BASED ON THE F-4B AIRPLANE.

	INITIAL SPEED	POWER
— — —	250 KCAS	MIL
———	350 KCAS	MIL
—— ——	450 KCAS	MIL
— — — — —	550 KCAS	IDLE*

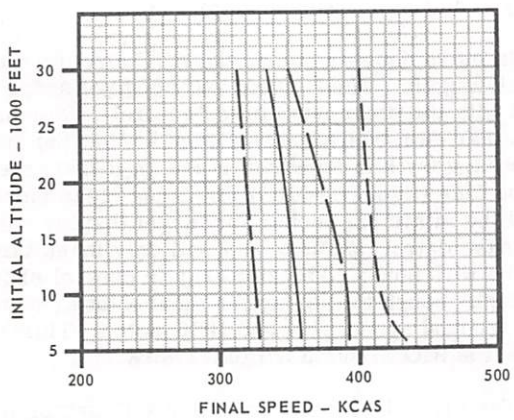
*IDLE POWER UNTIL AIRCRAFT IS VERTICAL. MILITARY POWER FOR REMAINDER OF TURN. (IDLE POWER IS USED FOR SPLIT-S MANEUVERS INITIATED ABOVE 450 KCAS.)

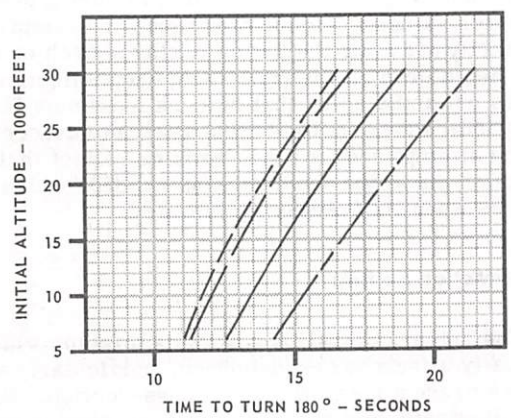
DIFFERENCES ATTRIBUTED TO CHANGE FROM F-4B TO F-4J AIRPLANE.

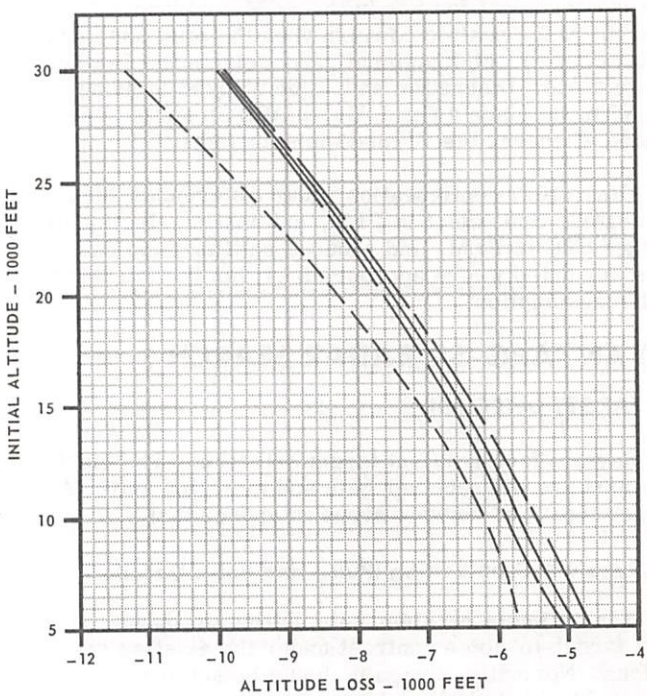
ALTITUDE LOSS	LESS THAN 60 FT	
TIME TO TURN	LESS THAN .4 SEC	
FINAL SPEED	MAX PWR +11 KCAS	MIL PWR +9 KCAS

DIFFERENCES ATTRIBUTED TO CHANGE IN POWER SETTING (350 KCAS AND 450 KCAS INITIAL SPEED ONLY).

	FOR INITIAL ALTITUDE			
	10,000 FT		30,000 FT	
	MAX	IDLE*	MAX	IDLE*
ALTITUDE LOSS	+100 FT	-30 FT	+200 FT	-100 FT
TIME TO TURN	-1 SEC	+1 SEC	-1 SEC	+1 SEC
FINAL SPEED	+50 KCAS	-20 KCAS	+35 KCAS	-10 KCAS







UNCLASSIFIED

FDB-1T-(53-2)

Figure 1-44 (U) (Sheet 2 of 2)

PART 2 RADAR TECHNIQUES

(U) This part discusses in detail the operation of the weapon system with recommended techniques to achieve maximum system performance. Techniques are recommended for functional operation of the AN/APG-59 and AN/APQ-72 radars in search, acquisition, and track, against low, medium, and high altitude targets. The AN/APG-59 and AN/APQ-72 information is presented separately, so that aircrews can read material pertaining to their aircraft without concerning themselves with material which pertains to another aircraft. On F-4N and some F-4B/J, the visual target acquisition set (VTAS) and the Sidewinder expanded acquisition mode (SEAM) are provided to enhance the weapon system capabilities in the ACM environment. Detailed applications of VTAS are discussed where applicable in the separate AN/APG-59 and AN/APQ-72 system descriptions. SEAM is discussed in part 3, this section. A general category pertaining to the radars, VTAS, and the AN/APX-76A interrogator, which is of interest to all aircrews, is presented after the AN/APG-59 and AN/APQ-72 radar descriptions.

AN/APG-59 RADAR DETECTION AND TRACK

(U) 1527 CONFIGURATION RADAR

(C) Operation of the 1527 configuration radar installed on some F-4J aircraft is essentially the same as for previous radar configurations. The minor modification of the controls and displays include:

a. The relocation of the antenna hand control combined with the "full throw" of the acquisition symbols facilitates RIO radar lockons.

b. The high and low-G acceleration limit selections allow the radar to maintain track on high-G maneuvering targets and still maintain a capability in an ECM environment. The G switch should normally be kept in NORM (high G) unless chaff is anticipated or encountered.

c. A 5-mile range scale is presented in the VI mode and is convenient for use in the ACM environment to prevent range scale confusion when the pilot assumes radar control which automatically selects the 5-mile range scale. Discretion should be utilized in using the VI mode since a fixed AIM-9 ASE circle is presented whenever the VI mode is selected.

(C) Other 1527 configuration radar differences such as altitude line reject in PLM, automatic selection of a fixed STC in PLM, and reduced settling time delays are noted where appropriate within the following radar description.

(U) AN/APG-59 RADAR SEARCH

(U) TARGET DETECTION

(U) Several factors affect target detection. The most common are the receiver gain and elevation settings, target size, and correct scope interpretation.

(U) Receiver Gain Setting (Pulse and Pulse Doppler)

(U) The optimum receiver gain setting produces the best target-to-noise contrast under the existing conditions. Normally, the gain should be set at the threshold of noise, as evidenced by the appearance of random noise peaks which produce a speckled appearance on the scope. This setting ensures that maximum contrast exists between targets and noise background. The setting varies between different radars. Therefore, the RIO should always adjust the gain control for optimum scope presentation, rather than position it to some predetermined point. While attempting initial detection, receiver gain should be adjusted slowly, and in small increments, above and below the optimum setting to obtain maximum target detection range. If receiver gain is set too low, an excellent target-to-noise contrast will exist but detection ranges will be degraded. Conversely, too high a gain setting will result in poor contrast, possibly resulting in reduced detection.

(C) In pulse doppler mode, the AGC circuits control receiver gain. The RIO can only control scope video gain with the clear and clutter controls. Normally, the clear gain control is adjusted so that the sweep paints a very thin smear of noise as it traverses the scope face (figure 1-46). Increasing clear video beyond the minimum needed for target display will not increase detection range and will only mask target return with noise. The clutter gain control should be set high enough to display the clear-clutter demarcation (ground speed) line and MBC notch. This will allow the RIO to monitor clutter lock.

(U) The erase button on the radar set control should be momentarily pressed periodically during search and after an unsuccessful radar lockon attempt. Momentarily pressing the button during search erases all video stored on the radar scope and effectively clears unwanted noise that hinders maximum target detection. Pressing the button after an unsuccessful lockon attempt reduces the "spoking" effect that remains on the scope from antenna nutation which commences when Half-Action is initiated.

(U) Elevation Setting

(C) The antenna elevation setting is a factor which critically affects target detection, particularly when targets present a small radar cross-section. Figure 1-45 illustrates the antenna beam coverage in azimuth and elevation. Antenna elevation should be set each time the aircraft is on the initial attack heading. The elevation scribe marks on the scope bezel are

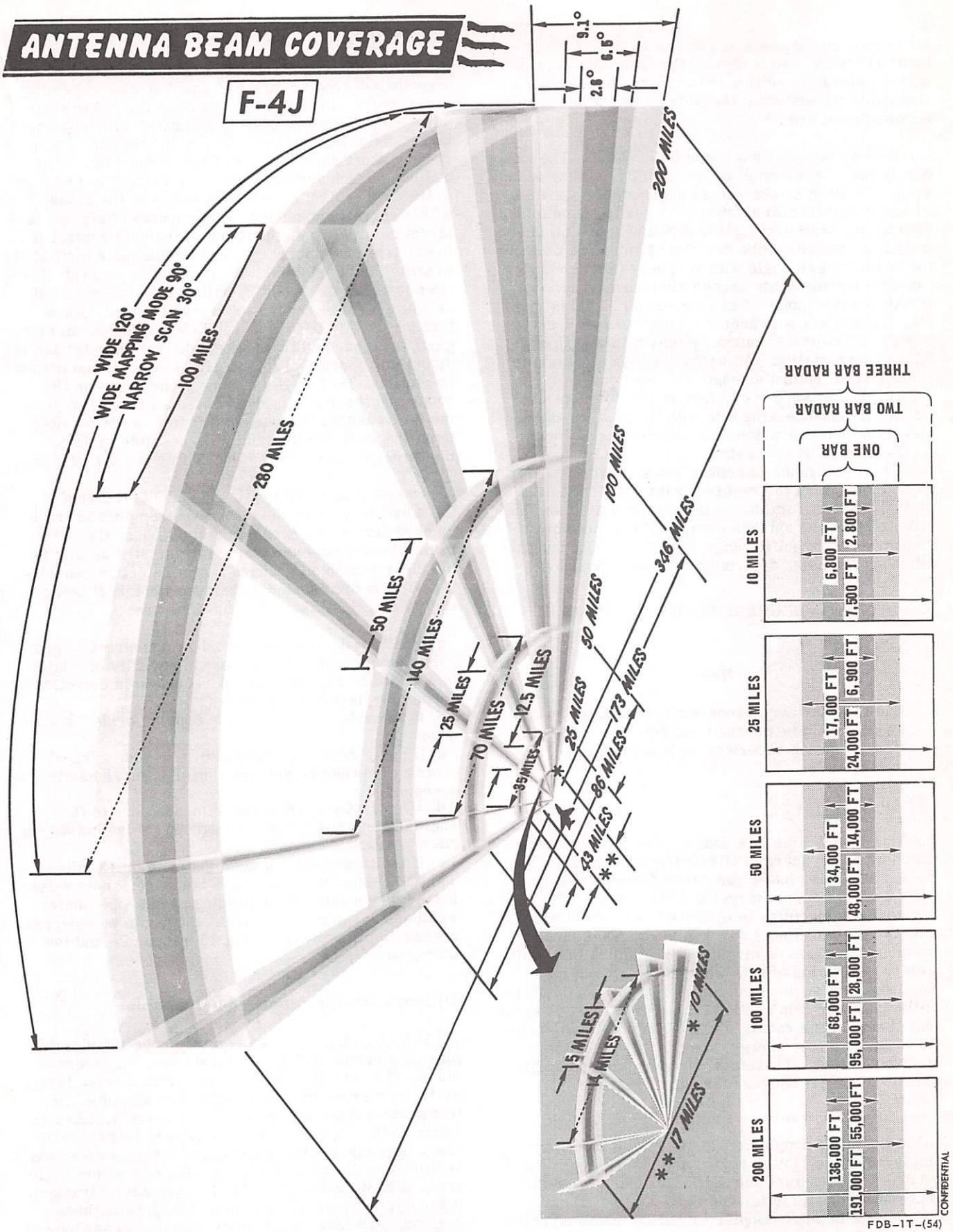

ANTENNA BEAM COVERAGE
F-4J
9.1°
6.5°
2.6°
WIDE 120°
WIDE MAPPING MODE 90°
NARROW SCAN 30°
100 MILES
280 MILES
200 MILES
100 MILES
346 MILES
50 MILES
140 MILES
25 MILES
70 MILES
12.5 MILES
35 MILES
50 MILES
25 MILES
173 MILES
86 MILES
43 MILES
5 MILES
14 MILES
10 MILES
17 MILES
THREE BAR RADAR
TWO BAR RADAR
ONE BAR
10 MILES
6,800 FT
2,800 FT
7,500 FT
25 MILES
17,000 FT
6,900 FT
24,000 FT
50 MILES
34,000 FT
14,000 FT
48,000 FT
100 MILES
68,000 FT
28,000 FT
95,000 FT
200 MILES
136,000 FT
55,000 FT
191,000 FT
CONFIDENTIAL
FDB-1T-(54)

Figure 1-45 (C)

(C)
for reference purposes and do not indicate true antenna elevation. As a result, the first step in proper antenna elevation setting is to determine accurate antenna level position. Methods by which this may be accomplished are:

a. Select boresight mode and GYRO OUT. The radar antenna positions 2° below the FRL and the radar scope elevation strobe should position to 0°; any elevation strobe deviation from 0° is due to scope misalignment. With boresight and NORM (gyro in) selected, elevation strobe deviation from 0° represents the antenna pitch angle with respect to the horizon.

b. Check pulse mode second-time-around echoes (STAE) on the scope. When maximum STAE is visible, the antenna is scanning a given altitude band slightly below the 0° antenna position in a gyro-stabilized presentation. Adjusting antenna elevation to reduce STAE return strength by about one-half will position the antenna very close to the 0° antenna position. Cross-checking this with the position of the elevation strobe provides a ready reference for the level position of the antenna.

c. Check the range of ground return. While still in pulse mode, turn the receiver gain down until only ground return from the main beam is visible on the scope. Move the antenna down until the main beam return is at a specific range (30 miles). Utilizing the following formula, determine true level position:

$$\frac{\text{ALT}}{\text{RNG} \times 100} = \text{DEGREES BELOW TRUE LEVEL}$$

Note

Due to radar gyro precessing, true level position should be checked periodically, particularly when experiencing high acceleration rates.

(U) Altitude Line

(U) The altitude line is a heavy band of clutter produced by radar energy reflected from the surface of the earth. This clutter can cause adverse effects when searching for a target at short range. The radar contains circuitry to eliminate the undesirable effects of the altitude line when in the track mode. However, there is no circuitry to diminish or eliminate its degrading effects when in the search mode. The RIO must accomplish this by proper manipulation of the receiver gain control. Since the target is in the main beam of the radar, and the altitude line is produced by side lobe energy, the target will be the stronger return. Therefore, proper gain reduction permits contrast between target and altitude line video.

(U) In the pulse doppler mode, side lobe return is displayed in the clutter region and, therefore, does not deter detection and acquisition of clear region targets. Main beam clutter and zero doppler (f_o) are notched out in pulse doppler to reduce unwanted noise in the clutter region.

(U) Weather

(C) In the pulse mode heavy clouds and rain will have a serious degrading effect on the detection capability of the radar. In very heavy weather the radar scope will generally be completely saturated with noise and target detection may be virtually impossible, except at very short ranges. The effect is equatable to low altitude search and detection over land. Manipulation of the gain control reduces the effect of the clutter with a corresponding and proportionate effect on the target return. If manipulation of the gain control is ineffective in reducing clutter, an alternate method is to switch to short pulse. Short pulse is present whenever low map mode and 25-mile range are selected, or when 10-mile range is selected in pulse. Burn through usually occurs at very short ranges. In marginal weather conditions, degraded target detection is directly proportional to the extent of scope saturation by clutter. There will be some clear areas on the scope and the aircraft should be maneuvered to place the target within these areas. If this is not feasible from the tactical situation, it is possible to detect the target in areas where the clutter is less intense.

(C) Rain and adverse weather cause degradation of the pulse doppler mode. Most weather phenomena is notched out of the scope presentation at the main beam clutter; however, false targets still appear in the clear region and reduce target detection capability. The recommended techniques for target detection in marginal weather conditions are:

a. Position the brightness and gain controls to provide best contrast with respect to severity of clutter introduced by the weather. A reduction in detection range may have to be accepted.

b. If possible search in pulse doppler mode, using wide scan.

c. If pulse search is employed, use wide scan as contrast between target and clutter is more easily descernible.

d. Use of wide scan is recommended due to the limited area covered and background noise buildup in narrow scan.

e. If the target has not been detected by 15 miles and pulse doppler operation is unusable, short pulse should be considered, depending upon scope clutter, weather, sea state, etc. Short pulse can be selected beyond 10 miles by selecting 25 mile scale and low map mode.

(U) Scope Interpretation - Pulse Doppler

(C) Velocity targets appear on the scope in pulse doppler as a bright spot at a discrete velocity and azimuth. The velocity target differs from a pulse target in that it may be slightly elongated in azimuth. Actual pulse and pulse doppler displays are depicted in figure 1-46. Velocity target brilliance increases as range decreases. The probability of target detection is limited in the clutter region. Targets within ± 110 knots of MBC and ± 50 knots of f_o can not be tracked. It is, however, possible to detect targets in these regions by locking on a turbine modulation associated with the aircraft being tracked. A turbine modulation

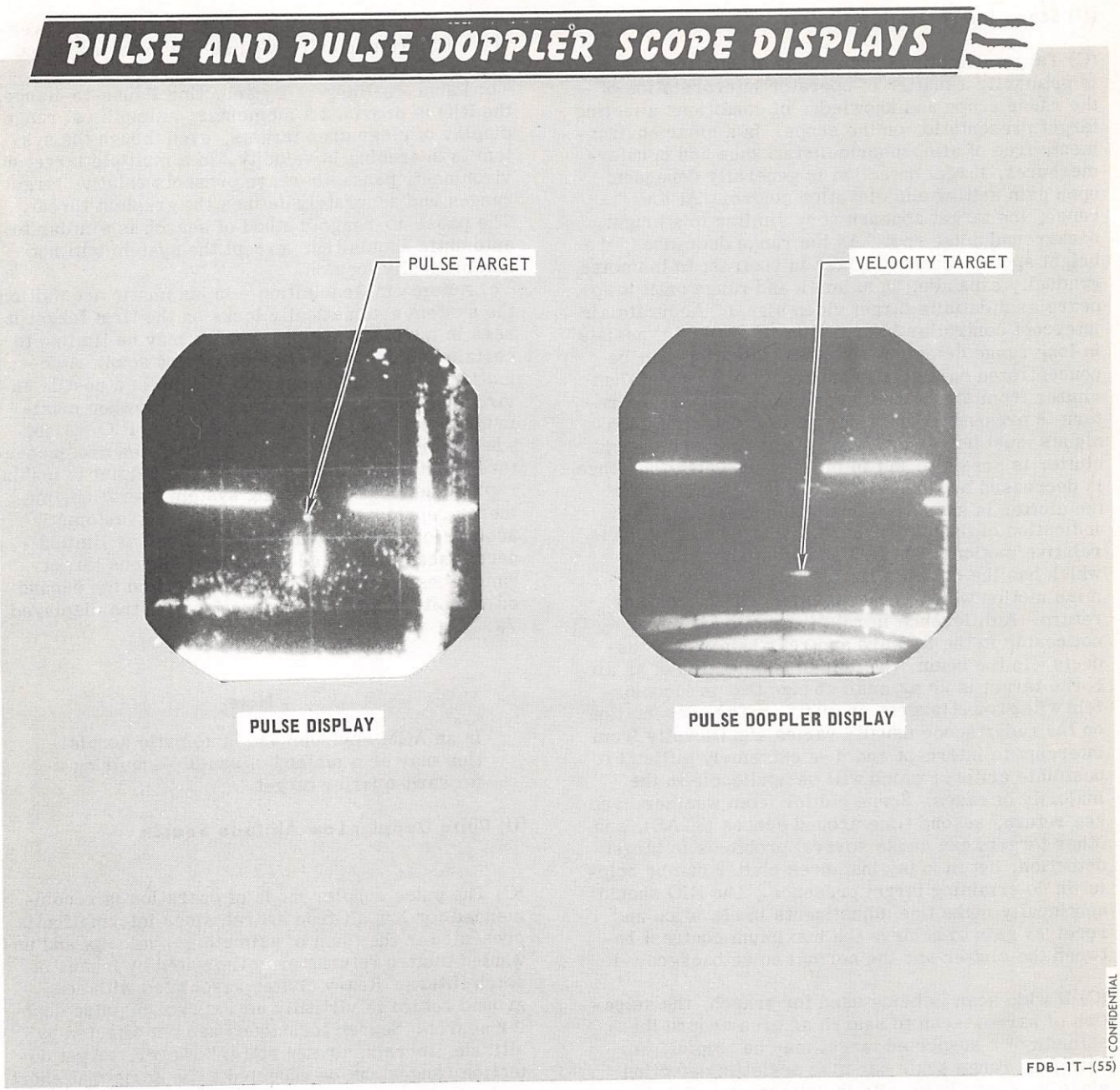


Figure 1-46 (C)

(C) can usually be tracked long enough to read target range and possibly make a relock to the pulse mode. If the radar is locked on the turbine modulation, vice the actual target. the V_C gap will be in error; however, range and target motion on the scope will be accurate.

(U) Expanded Velocity Display

(C) The expanded velocity display is a most valuable aid in determining target information. It is presented on a vertical scale in pulse doppler mode when automatic track commences. Actual target video is displayed along with the radar velocity gate. The region covered is 900 knots centered around the velocity gate. The RIO should continually monitor this display since any change in target velocity first becomes apparent on this A-scope display. Target position in relation to main beam clutter should be noted to determine any target jink or target proximity to MBC or the f_O notch. As the target approaches MBC, a rapid relock should be initiated since the radar will not track through MBC. In addition, loss of target track is readily apparent by separation of velocity gate and actual target video and subsequent resweep of the velocity tracking gate as it attempts to reacquire the target. The expanded velocity display gives the aircrew the ability to see a target velocity gate stealer and/or possible target employment of chaff. Knowledge of this ECM information enchances the aircrew's ability to counter these deception techniques.

(U) Scope Interpretation (Pulse)

(C) Target detection, regardless of relative altitude, is primarily a matter of operator interpretation of the radar scope and knowledge of conditions affecting target presentation on the scope. In a clear environment, free of atmospheric disturbance and countermeasures, target detection is generally dependent upon gain setting and elevation control. At long range, the target appears very similar to a bright background noise spot. As the range decreases, the bright spot becomes brighter in contrast to the noise, gradually expanding in azimuth and range until it appears as a definite target video signal. Accurate air intercept controller information (if available) assists in long range detection since RIO attention can be concentrated on a small portion of the scope. When clutter from atmospheric conditions or land/sea return is present on the scope, target detection techniques must be varied. Long range detection beyond clutter is possible, but in most cases detection range is decreased because video gain is reduced so that the clutter is sharply defined. the most apparent indication of target presence in clutter conditions is relative motion. The RIO should study each echo which has the characteristics of a target to determine motion which is inconsistent with the clutter return. A difference in relative motion is most noticeable in the forward and rear hemisphere aspects. In the beam, the primary indication of an airborne target is an azimuth change that is inconsistent with ground targets or clutter. The presentation on the radar scope usually varies significantly from intercept to intercept and it is extremely difficult to postulate criteria which will be applicable in the majority of cases. Scope clutter from weather, land/sea return, second time around echoes (STAE), and other targets can cause several problems in target detection, but in many instances clutter can be helpful in determining target presence. The RIO should continually make fine adjustments in elevation and receiver gain to achieve the maximum contrast between the clutter and the normal noise background.

(C) If wide scan is being used for search, the selection of narrow scan to search an area around the azimuth of a suspected target may be helpful. A change in range scale can also assist in detection since it generally results in better contrast between the noise background and the clutter. This is true only when changing to a larger display scale (i.e., shorter range, 50-mile to 25-mile). It is not true when changing to a smaller display scale (i.e., longer range, 25-mile to 50-mile).

(U) PULSE DOPPLER SEARCH

(C) There are three methods of search in the pulse doppler mode of operation: Velocity search, Pause-to-Range, and Automatic Acquisition.

a. Velocity search - In velocity search, the RIO may select and acquire a desired target. Targets are presented in an azimuth vs. velocity display and may be acquired in both the clear and clutter regions. Numerous combinations of velocity coverage search are available; however, detection capabilities are greater in most instances if the RIO utilizes a constant switch setting. V_C - HIGH and velocity coverage - GS are normally used unless expected threat TAS is in excess of 1500 knots.

b. Pause-to-Range - By selecting Pause-to-Range, the RIO is provided a momentary azimuth vs. range display of clear area targets, even though the system is searching in velocity. In a multiple target environment, pause-to-range presents relative target ranges and accurately defines the greatest threat. The pause-to-range method of search is similar to automatic acquisition, except the system will not automatically lock on.

c. Automatic Acquisition - In automatic acquisition the system automatically locks on the first target it sees in the clear region. Search may be limited to certain sectors by the use of narrow scan. Automatic acquisition is highly desirable in a hostile environment during autonomous search, when maximum visual lookout is required by the RIO. Also, when short range detection opportunities are encountered, automatic acquisition will be helpful in making rapid acquisition. If during system operation, numerous spurious targets are acquired, automatic acquisition should be discontinued unless limited sector scan is deemed reliable. Spurious targets can be best recognized and identified on the expanded velocity display in conjunction with the displayed V_C .

Note

In an ACM environment, automatic acquisition may be a method of rapidly acquiring a forward-quarter target.

NEW

(U) Pulse Doppler Low Altitude Search

(C) The pulse doppler mode of operation is recommended for low altitude search since information is presented in the form of azimuth vs. velocity and unwanted clutter returns are eliminated by means of notch filters. Heavy clutter associated with sea/ground return is virtually nonexistent in pulse doppler search. Search techniques are not affected by altitude, terrain, or sea state; however, target detection ranges can be expected to be somewhat shorter in the low altitude environment. Although numerous combinations of search velocity coverage are available, the two switch combinations that yield the greatest change of detecting most targets are:

a. Velocity coverage - GS, V_C - HIGH (0 - 3000 kts)
b. Velocity coverage - INC, V_C - LOW (200 - 1200 kts)

(C) In extremely mountainous terrain a target may momentarily disappear due to terrain masking. If this situation exists, it is recommended that the F-4 gain an altitude advantage over the target.

(U) PULSE SEARCH

(C) Search in pulse mode is greatly affected by many factors, including terrain, altitude, weather, radar set performance, and radar set tuning techniques.

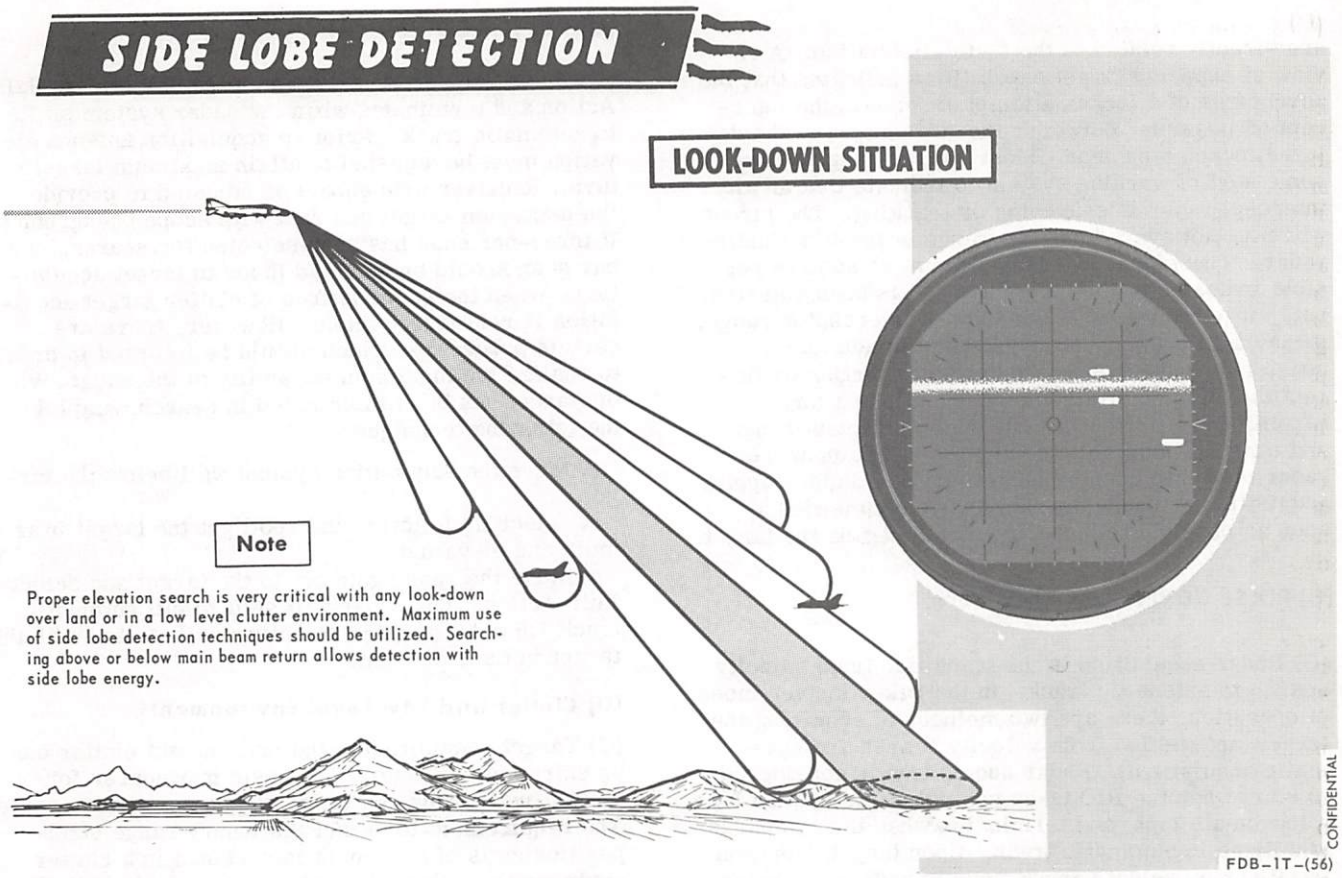


Figure 1-47 (C)

(U) Pulse Low Altitude Search

(C) The pulse mode is considered to have little search capability against low level targets over land. Radar return from the ground effectively saturates the radar scope and usually obliterates any target return. As target altitude is increased and interceptor altitude is decreased, radar detection capability is improved. Detection capability can be further related to the type of land background. Over relatively flat areas, particularly jungle or other relatively poor radar reflective surfaces, radar search is slightly improved. Over valley or mountainous terrain, the radar reflectivity of the land mass is much greater with resultant reduction in radar detection. The RIO's problem is to detect relative motion between target returns and background clutter. In head-on attacks against large targets, the target appears to be closing faster than the clutter whereas in tail-on attacks, the target appears relatively stationary compared to clutter movement. The following radar set tuning procedures are recommended:

a. Radar set tuning for low altitude (F-4 and Bogey)

(1) Select operate with antenna set for no ground return.
(2) Slowly adjust elevation control down for a slight amount of ground return (lower side lobe on the deck).
(3) With elevation control set as described, the gain control can be used to increase or decrease return as desired.
(4) Receiver gain will normally be reduced to a lower noise level in the higher clutter areas.

b. Radar set tuning for a look-down situation.

(1) Position the elevation control so that main beam clutter is displayed in the region of the target.
(2) Position receiver gain control for sharply defined main beam return and where traces of the first side lobe return are visible.
(3) Search for target with the side lobes as indicated in figure 1-47.

(U) AN/APG-59 RADAR ACQUISITION

(U) TIME OF ACQUISITION

(C) There are two basic schools of thought on the proper time, or range, during an intercept when an acquisition attempt should be made, and there are advantages and disadvantages to each proposal. One theory is to delay acquisition until just prior to missile firing range. The other theory is to attempt acquisition as soon in the intercept as possible and to continue acquisition attempts until successful. Several factors must be considered when determining the proper time for target acquisition. These factors

(C)
are directly related to the tactical situation. A review of expected target capabilities indicates that the advantages of a lockon attempt as soon in the intercept as possible, outweigh the advantages of the delayed lockon technique. Most tactical targets have some sort of warning system to indicate that an air intercept radar is searching or tracking. The targets will not, however, know the range of the illuminating radar. Therefore, a lockon attempt as soon as possible indicates to the target that it has been detected, but, since the target is unaware of interceptor range, it may also prompt the target crew to activate a countermeasure system or use other tactics to disrupt the attack. Invaluable information on target capabilities will be available while sufficient range and time are available to vary the situation and/or radar modes to counter target tactics. Pulse doppler acquisition or pause-to-range is recommended as soon as possible to more accurately define the target.

(U) PULSE DOPPLER ACQUISITION

(C) Radar acquisition is the transition from velocity search to automatic track. In the pulse doppler mode of operation, there are two methods of acquiring the target (acquisition from velocity search and automatic acquisition). Radar acquisition is considered to start when the RIO takes control of the system for a lockon attempt, and terminates when the system is stabilized in automatic track. Upon target detection the RIO may select narrow scan to reduce eclipsing and increase target build-up on the scope. Elevation should then be adjusted to spotlight the target prior to lockon.

(U) Acquisition From Velocity Search

(C) Acquisition is accomplished by going to Half-Action, placing the velocity gate over the target and pressing the action switch to Full-Action. Target fades that occur while the antenna is still scanning may be caused by either eclipsing or an elevation error. Avoid moving the elevation scan until the PRF completely cycle. Rather than wait for the complete PD search PRF switching cycle, initiate rapid PRF switching by momentarily selecting Half-Action. Spotlighting the target prior to attempting acquisition enhances rapid acquisition.

(U) Automatic Acquisition

(C) Automatic acquisition is accomplished by selecting AA on the PD search switch. The first clear area target in the radar beam is automatically acquired and tracked. Automatic acquisition is optimized in narrow scan which reduces spurious acquisitions. System operation is discussed in detail under Pulse Doppler Search, this section.

(U) Pulse Doppler Manual Track Acquisition

(C) With the present mechanization, pulse doppler manual track is extremely difficult. This method of tracking a target should be used only as a last resort.

(U) PULSE ACQUISITION

(C) Pulse acquisition starts with the selection of Half-Action and terminates when the radar system shifts to automatic track. Prior to acquisition antenna elevation must be adjusted to attain maximum target return. Receiver gain should be adjusted to provide the maximum target contrast with scope background. If three-bar scan has been selected for search, one-bar scan should be selected prior to target acquisition. When the scope is free of clutter target acquisition is relatively simple. However, there are certain procedures which should be followed in order to realize the maximum capability of the radar. When the target has been illuminated in search, employ the following technique:

a. Move the acquisition symbol well below the target.

b. Select Half-Action and spotlight the target in azimuth and elevation.

c. Move the range gate out to the target and select Full-Action. The radar will shift to full automatic track 1.5 seconds after selecting Full-Action with the target in the range gate.

(U) Clutter and Low Level Environments

(C) Target acquisition in the presence of clutter can be extremely difficult. The basic procedures for target spotlighting and range strobe positioning apply. The requirement for exact stationary range strobe positioning is of maximum importance in a clutter environment. Since the radar is relatively unlimited in range track acceleration during acquisition and is mechanized to accept the simplest tracking solution with the lowest closing velocity, there is an extremely high probability of locking on clutter if there is considerable movement of the range strobe around the target with Full-Action selected. Prior to acquisition, every attempt should be made to maneuver so that the target is separated both in azimuth and range from the clutter and acquisition can be attempted in a relatively clear area. Low altitude target acquisition presents additional problems because the clutter band extends across the entire scope in azimuth. The length of the clutter band in range is almost totally dependent upon the sea state or type of terrain, and the elevation setting. In some instances at very low altitude, the main beam clutter may extend out from the very close range. The RIO should attempt target acquisition beyond the main beam clutter to reduce the probability of locking on the ground/sea return. If acquisition attempts are unsuccessful and the target enters the main beam clutter, acquisition will be extremely difficult and locks on the clutter should be anticipated. With the AN/APG-59 the only alternative available may be selection of short pulse. Locks on clutter are less frequent in short pulse because of the narrow (0.65 microsecond) range tracking gate in this mode. A range lockon to a clutter signal is immediately indicated to the RIO by a near maximum opening or closing range rate display with accompanying rapid range strobe movement in range and downward antenna movement to follow the clutter. If the RIO desires to utilize short pulse (0.65 microsecond), he must either switch to the 10-mile scale while still in search or switch to low map mode with the 25-mile scale selected.

(U) Pulse Manual Track Acquisition

(C) To acquire a target in the manual mode, select the manual position on the track switch. Assume manual control of the radar antenna position in azimuth and elevation while manually controlling range and range rate by means of the manual velocity knob. There is no semi-manual track feature in the AN/APG-59 radar.

Note

In the AN/AWG-10, pulse manual track limits the system to wide speedgate.

(U) Pilot Lockon Modification (PLM)

(C) The pilot lockon modification (PLM) gives the pilot an opportunity to automatically acquire a target within 5 miles if visually boresighted. It should be activated during ACM engagements when the RIO fails to acquire the target or in any high clutter environment where normal pulse lockon is impracticable. It is a secondary mode of radar operation but can be a valuable assistance to the aircrew. PLM, however, requires an accurate target tracking capability for initial radar acquisition. Therefore, periodic target boresighting exercises should be conducted by the pilot. Two different PLM configurations may be installed on the aircraft. Immediately following is a discussion of PLM procedures on aircraft without the 1527 configuration radar set. Following this discussion is a description of the 1527 configuration radar set PLM procedures.

(C) To select PLM on aircraft without the 1527 configuration radar set, the pilot need only press the nose wheel steering button on the control stick grip. When the button is pressed the following sequence of events occurs:

a. The radar antenna goes to boresight. Short pulse mode and 5-mile scale are automatically selected. Pulse mode is always selected even though pulse doppler may have been the prior operating mode.
b. After a 0.5 second delay the range gate sweeps from 1/3 to 5 miles.
c. When the target and range gate are coincident, full system radar track commences. If the range gate fails to acquire the target on the first sweep it will return to 1/3 mile and resweep to 5 miles until lockon occurs or the nose wheel steering button is released.

Note

Break lock is accomplished by either selecting Half-Action on the radar hand control or by momentarily pressing the nose wheel steering button.

(C) Altitude line video (side lobe clutter) is reduced by addition of STC (sensitivity time control) circuits. In effect STC eliminates altitude line lockon. STC is controlled by a guarded gain pot located around the erase button on the radar set control.

(C) Effective utilization of PLM requires that the aircraft be properly boresighted and the STC gain control be adjusted to eliminate altitude line lockon. The radar antenna and optical sight pipper (when set at 35 mils) must coincide or the error must be known and noted on the yellow sheet. The recommended procedure for setting STC is to climb to 12,000 feet and activate PLM. The RIO should then adjust the STC gain pot to a position where the range gate locks on the altitude line. The STC gain pot should then be turned down (counterclockwise) in small increments to a position where the altitude line is not acquired.

Note

- PLM cannot be activated during autopilot operation or manual track.
- Radar interlocks are not overridden in PLM unless the pilot has selected interlocks - OUT.
- Wait 4 seconds after a PLM lockon before firing an AIM-7 missile. Refer to Time Delays, this section.

(C) On aircraft with 1527 configuration radar sets, the PLM capabilities are improved. These improvements include altitude line reject, high-G acceleration limits, automatic selection of a fixed STC, and a reduced settling time delay. When the pilot initiates lockon, the radar automatically attempts to acquire the altitude line by utilizing an altitude line tracker. The altitude line tracker output is then used to blank the radar range gate as it sweeps through the altitude line range, thus preventing range gate locks on the altitude line. Approximately 1 second is required for altitude line lockon sequence. The pulse range tracker high-G acceleration limiter is automatically selected when the pilot initiates radar lockon. This increases the tracking acceleration limits to 6.7G and improves the radar capability of retaining lock in an ACM environment. The reduced radar settling time allows an AIM-7 shot 1.5 seconds after radar lockon. Target acquisition is accomplished as follows (radar in OPR):

a. VTAS mode switch - SEAM/PLM
b. Weapon select switch - SP or GN
c. Pilot boresights target.
d. Press TAE to Half-Action. Radar attempts to acquire altitude line and then antenna slaves to boresight. Five-mile range and short pulse are automatically selected. The altitude line tracker only sweeps once through the 5-mile range and is then disabled.

(C) For automatic lockon:

e. Press TAE to Full-Action. Radar range gate sweeps from 0.45 mile out toward 5 miles in attempt to acquire target. A main beam clutter reject circuit is activated to reduce the probability of acquiring MBC during the range gate sweep.
f. When radar lockon is achieved, release TAE. Second order track is established 0.63 second after lockon. After narrow band (second order) track is established, the altitude line tracker is put on memory for 5 seconds and then disabled. Radar automatically range and angle tracks target.

(C)

g. If the range gate fails to acquire the target, it returns to 0.45 mile and resweeps towards 5 miles until lockon occurs or until the TAE is released.

Note

- For automatic lockon, the TAE may be pressed immediately to Full-Action after the target is boresighted. Range gate sweep and radar lockon are not enabled until after the altitude line lock attempt and the antenna slaves to within 3° of boresight.
- Keep the target centered on the gunsight reticle (35-MIL depression) until lockon is achieved.

(C) Provisions are made for manually locking the radar on a target during PLM if desired. For manual lockon:

h. After target is boresighted, pilot presses and holds TAE in Half-Action; RIO presses action switch to Half-Action to obtain manual control of range gate.

i. Move range strobe over target in B-sweep with the antenna hand control and press action switch to Full-Action to lock on target.

j. When radar lockon occurs, release TAE and action switch. Radar automatically range and angle tracks target.

(C) Lockon can be rejected by momentarily pressing the TAE or action switch to Half-Action. When lockon is rejected, the radar returns to the mode and condition of operation it was in prior to lockon initiation.

Note

- The AIM-7E-2 dogfight mode is automatically selected (1527 configuration radar set) when lockon is achieved if aircraft altitude is less than 32,000 feet and target range is less than 5 miles. This bypasses the firing interlocks for all AIM-7 missiles.
- On aircraft with 1527 configuration radar sets, wait 1.5 seconds after a PLM lockon before firing an AIM-7 missile. When the dogfight computer is installed, the SHOOT light flashes approximately 1.5 seconds after a PLM lockon if within the computed ACM launch zone for a maneuvering target. Refer to F-4B/N and F-4J Firing Delay, this section.

(U) VTAS/Radar Mode Acquisition

(C) With the installation of VTAS, the pilot is provided with an integrated system that combines the features of the pilot lockon modification with that of a helmet sight. The pilot can visually acquire the target and lock the radar on the target by operating a single, control-stick-mounted switch. VTAS eliminates the requirement for accurate target tracking through the gunsight. The altitude line reject, high-G acceleration limit selection, automatic selection of a fixed STC, and reduced settling time delay features mentioned in the 1527 configuration radar set PLM description also apply in the VTAS/RADAR mode when VTAS is utilized in conjunction with a 1527 configuration radar set. Provided the radar is operating, target designation and acquisition is accomplished as follows:

a. VTAS mode switch - VTAS

b. VTAS power switch - ON

c. Weapon select switch - SP or GN. VTAS/RADAR mode discrete light illuminates.

d. Look at target and center it on the helmet sight reticle.

e. Press TAE to Full-Action for automatic lockon. Radar antenna sweeps at +16° and altitude line tracker acquires altitude line. In approximately 1 second, antenna slaves to pilot's line of sight; 5-mile range and short pulse are automatically selected.

Note

- Helmet sight reticle blinks if pilot's line of sight angular displacement from boresight exceeds radar antenna slaving limits (± 60°, azimuth and elevation).
- Reticle extinguishes if pilot's helmet is not within sensor surveying unit coverage envelope (approximately ± 75°).

f. Radar range gate sweeps from 0.45 mile out toward 5 miles in attempt to acquire target. MBC reject circuit is activated as in PLM.

Note

Keep the target centered on the reticle until lockon is achieved.

g. When radar lockon discrete light (lower right light) illuminates, TAE may be released. As in PLM, second order track is established in 0.63 second. Also, altitude line tracker is put on memory for 5 seconds and then disabled. Radar automatically range and angle tracks target.

(C) If a manual VTAS/RADAR mode lockon is desired:

h. After target is centered on the helmet sight reticle, pilot presses and holds TAE in Half-Action. RIO presses action switch to Half-Action to obtain manual control of range gate.

i. Move range strobe over target in B-sweep with antenna hand control and press action switch to Full-Action to lock radar on target.

j. When radar lockon occurs, TAE and action switch may be released. Radar automatically range and angle tracks target. Radar lockon discrete light illuminates and VTAS/RADAR mode discrete light extinguishes unless pilot's line of sight remains within 3° of radar antenna look angle.

k. To visually re-acquire target being tracked by radar, note antenna position from scope indications and visually scan this area of space. VTAS/RADAR discrete light (upper right light) illuminates when pilot's line of sight is within 3° of the radar antenna look angle. Target should be along this line of sight.

(C) Target lockon may be rejected by momentarily pressing TAE or action switch to Half-Action. When lockon is rejected, the radar returns to the mode and condition of operation it was in prior to lockon initiation.

Note

- The AIM-7E-2 dogfight mode is automatically selected (1527 configuration radar set) when lockon is achieved if aircraft altitude is less than 32,000 feet and target range is less than 5 miles. This bypasses the firing interlocks for all AIM-7 missiles.
- On aircraft with 1527 configuration radar sets, wait 1.5 seconds after a VTAS/RADAR mode lockon before firing an AIM-7 missile. When the dogfight computer is installed, the SHOOT light flashes approximately 1.5 seconds after VTAS/RADAR mode lockon if within the computed ACM launch zone for a maneuvering target. Refer to F-4B/N and F-4J Firing Delay, this section.

(U) AN/APG-59 RADAR TRACK

(C) The radar has provisions for the following tracking modes:

a. Automatic track

(1) PD
(2) Pulse

b. Manual track

(1) PD
(2) Pulse

c. Jam angle track

(1) AOJ

(a) PD
(b) Pulse

(2) HOJ

(a) PD
(b) Pulse

d. J track

(1) PD

(C) ECCM modes are discussed in section 1, part 8 of Supplement Tactical Manual, NAVAIR 01-245FDB-1T(A).

(U) PULSE DOPPLER TRACK

(U) Pulse Doppler Automatic Track

(C) Following acquisition the scope presentation is a range vs azimuth display. Present on the scope is a synthetic target, at a range determined by the FM ranging voltages, aim dot, ASE circle, R_a and R_{min} strobes, and V_c circle, plus an expanded velocity presentation on the left side of the scope.

(C) During automatic track the memory light illuminates when V_c is within ± 110 knots of the predicted main beam clutter. The memory light also illuminates when the velocity gate separates from the target. This condition can be immediately identified by oscillation of the V_c gap and expansion of the velocity display as the radar resweeps in an attempt to reacquire the target. At this time a rapid relock should be attempted by going to Half-Action and placing the velocity gate over the target on the expanded velocity display and then going to Full-Action.

(C) During automatic track the split elevation strobe and the manually controlled elevation strobe should be matched. Wide scan should be selected to be prepared for a rapid reacquisition in case of a broken lock.

(U) Pulse Doppler Manual Track

(C) Pulse doppler manual track is recommended only if no other tracking mode is available in pulse or pulse doppler. Refer to Pulse Doppler Acquisition, this section.

(U) PULSE TRACK

(U) Pulse Automatic Track

(C) Automatic target tracking commences 1.5 seconds after selecting Full-Action with the target in the range gate. On aircraft with 1527 configuration radar sets, automatic target tracking commences 0.63 second after selecting Full-Action with the target in the range gate if the high-G switching command is enabled (G switch in NORM or missile interlock switch in DOGFIGHT and during PLM or VTAS/RADAR mode locks). During the tracking mode the radar tracks the target automatically in range, azimuth, and elevation without any requirement for RIO inputs. The RIO must, however, monitor the radar to ensure that the target track is maintained, and be prepared to reacquire the target if the track should break or lock should transfer to another target. The indications of track break, an impending lock break, or a lock transfer are the V_c gap, R_a and R_{min} strobes, the memory light, and the B-sweep. When the radar is stabilized in steady track, the position of the V_c gap and the R_a and R_{min} strobes remain constant. If the V_c gap starts to oscillate and the R_a and R_{min} strobe positions jump in and out, the indication is that the range track is in error. In pulse automatic track, the memory light illuminates when V_c is within ± 110 knots of predicted MBC. Illumination of the light because of this circumstance does not indicate an interruption of automatic track. It only informs the aircrew that V_c is approaching predicted MBC (i.e., beam closure). If the memory light illuminates for more than 3 seconds, V_c is not within ± 110 knots of predicted MBC, and the J light is not illuminated, the radar is tracking in memory. The RIO should select Half-Action and reacquire the target. The memory light may illuminate without changes in range rate or R_a/R_{min} strobe position. This is again indicative of a shift to range memory and the target should

(C)
be reacquired. Unanticipated B-sweep movement in azimuth, with or without an elevation strobe change, indicates a break in angle track. If the B-sweep azimuth changes and the memory light illuminates, the system has probably lost angle track and will break lock after the expiration of the 5 to 7 second range memory tracking time. The RIO should select Half-Action and reacquire the target. If the target is acquired in chirp, the radar will not shift to short pulse when selecting the 10-mile scale unless the RIO goes to Half-Action and then back to Full-Action. For an AIM-7 attack, if acquisition occurs outside of 10 miles it is not recommended to try and reacquire the target in short pulse from chirp mode (25-50 mile scale). The advantage of maintaining a stabilized track display is that V_c and speedgate positioning far outweigh the added accurate minimum range tracking capabilities of short pulse. If, however, the target is within 10 miles range and/or the pilot is closing for an AIM-9 or AIM-7E-2 rear quarter shot, it is recommended that the radar be in short pulse since the target can be accurately tracked to a lesser range. The RIO should be prepared for rapid target reacquisition in the event of a lock transfer or break lock. If pulse mode is still desired or required, the following switch position on the radar set control should be selected:

Scan - 1 Bar
Sweep - Wide
Mode - Pulse
Receiver gain - for normal search

(C) The radar set is now reset so that the RIO can take action to reacquire the target. The manually controlled elevation strobe should be continually repositioned to actual antenna look angle to ensure that the antenna is looking at the target in case of break lock, thereby hastening relock capabilities.

NEW (C) On aircraft with the dogfight computer, the dogfight computer launch zone computations are always displayed by the SHOOT light and the gunsight reticle when a missile is ready for firing and the target is in range. When DOGFIGHT is selected with the missile interlock switch, the dogfight computer also controls the following displays on the radar scopes: R_a and R_{min} strobes, break X, and IN RNG light.

Note

The R_a and R_{min} strobe positions will probably change if the pilot manually selects the AIM-7E-2 dogfight mode during automatic track. This is caused by a shift from fire control computer solutions to dogfight computer solutions (maneuvering target launch zone computations).

(U) Pulse Manual Track

(C) For manual track, the range strobe should be maintained about 1 mile behind the target in range with range rate adjustments as required. Manual gain control is required in manual track in addition to manual inputs of range, range rate, azimuth, and elevation. At ranges beyond 25 miles, manual tracking is relatively easy despite large elevation differences and changing azimuth. Inside 25 miles, manual track becomes significantly more difficult, particularly with azimuth or elevation changes. It is recommended that the intercept geometry be stabilized, particularly in altitude, and manual tracking commenced at ranges of 15 miles or less. For a satisfactory AIM-7 launch, the target track in azimuth must be smooth and without abrupt azimuth changes which can cause large aim errors in the AIM-7 at launch and preclude successful missile operation. The altitude line presents a problem because receiver gain must be reduced to maintain contact with the target. This can be eliminated and contact retained with the target if the RIO maintains steady track while reducing gain as the target approaches the altitude line. Since the altitude line is a side lobe return and the target is in the main beam, video gain can be reduced to the point where the altitude line effectively disappears but the target is still visible. Care should be taken with this technique, however, since with a very high gain reduction, the target can easily be lost while it is traversing the altitude line.

(U) TRACKING IN CLUTTER ENVIRONMENT

(C) The radar is susceptible to break locks or lock transfers to clutter in all conceivable tactical environments. This susceptibility is not easily defined except to note that the probability is higher as the clutter increases. There have been no recorded instances of lock transfer to STAE. Break locks or lock transfers to weather clutter are very common particularly when the target is operating in or very close to the weather. In low level intercepts, lock breaks and transfers to ground/sea clutter should be anticipated. This is especially true over water when the target flies over surface contacts. Once automatic track has been established, the RIO has no control over the tracking features of the radar. The only precautions which can be taken are close monitoring of the attack presentation and effective, fast lockon techniques, to accomplish a rapid relock if the radar shifts or breaks lockon.

(U) RAPID RELOCK

(C) A rapid relock to the pulse mode should be initiated whenever possible. Since the AN/APG-59 has little capability of tracking a target through main beam clutter in pulse doppler, it behooves the RIO to get the radar in pulse track as soon as practical. Rapid relock to pulse mode is best accomplished by the following procedure:

a. Ensure target range is within the pulse radar detection and tracking capabilities.
b. Note approximate target altitude by the delta H indication on the ADI and attempt to get slightly below this target elevation.
c. Align the manual controlled elevation strobe with the target tracking elevation strobe. This aids target reacquisition in case of radar break lock.

(C)

d. While maintaining Half-Action, switch to pulse mode and look for the target in the B-sweep. If the target is visible, pull the range strobe over the target and initiate Full-Action.

Note

NEW

- Allow 4 seconds after a rapid relock before firing AIM-7 missiles. On aircraft with 1527 configuration radar sets, only a 1.5-second delay is required.
- If the target is not visible, return to the pulse doppler mode, ensure target and velocity strobes are aligned and initiate Full-Action. If time and tactical situation permit, attempt another rapid relock at a more favorable position.
- Rapid relock of targets over water should be attempted between 30-15 miles. If the relock to pulse mode has not been completed by 12 miles, no further attempt should be made unless absolutely necessary to maintain radar track; i.e., beam intercept where PD track is improbable.
- Relocks over land become more critical due to land/background clutter.

AN/APQ-72 RADAR DETECTION AND TRACK

(U) AN/APQ-72 RADAR SEARCH

(U) TARGET DETECTION

(U) Several factors affect target detection. The most common are the receiver gain and elevation settings, target size, and correct scope interpretation.

(U) Receiver Gain Setting

(U) The optimum receiver gain setting produces the best target-to-noise contrast under the existing conditions. Normally, the gain should be set at the threshold of noise, as evidenced by the appearance of random noise peaks which produce a speckled appearance on the scope. This setting ensures that maximum contrast exists between targets and noise background. The setting varies between different radars. Therefore, the RIO should always adjust the gain control for optimum scope presentation, rather than position it to some predetermined point. While attempting initial detection, receiver gain should be adjusted slowly, and in small increments, above and below the optimum setting to obtain maximum target detection range. If receiver gain is set too low, an excellent target-to-noise contrast will exist but detection ranges will be degraded. Conversely, too high a gain setting results in poor contrast, possibly resulting in reduced detection.

(U) Elevation Setting

(C) The antenna elevation setting is a factor which critically affects target detection, particularly when targets present a small radar cross-section. Figure 1-48 illustrates the antenna beam coverage in azimuth and elevation. Antenna elevation should be set each time the interceptor is on the initial attack heading. The elevation scribe marks on the scope bezel are for reference purposes and do not indicate true antenna elevation. As a result, the first step in proper antenna elevation setting is to determine accurate antenna level position. Methods by which this may be accomplished are:

a. Select boresight mode and gyro OUT. The radar antenna positions 2° below the FRL and the radar scope elevation strobe should position to 0°; any elevation strobe deviation from 0° is due to scope misalignment. With boresight and NOR (gyro in) selected, elevation strobe deviation from 0° represents the antenna pitch angle with respect to the horizon.

b. Check second-time-around echoes (STAE) on the scope. When maximum STAE is visible on the scope, the antenna will be scanning a given altitude band slightly below the 0° antenna position in a gyro-stabilized presentation. Adjusting antenna elevation to reduce STAE return strength by about one-half positions the antenna very close to the 0° antenna position. Cross-checking this with the position of the elevation strobe provides a ready reference for the level position of the antenna.

c. Check range of ground return on the scope. With the radar in MAP mode, turn the receiver gain down until only ground return from the radar main beam is visible on the scope. Move the antenna down until the radar main beam return is at a specific range (30 miles). Utilizing the following formula, determine true level position:

$$\frac{\text{ALT}}{\text{RNG} \times 100} = \text{DEGREES BELOW TRUE LEVEL}$$

Note

Due to radar gyro precessing, true level position should be checked periodically, particularly when experiencing high acceleration rates.

(U) Altitude Line

(U) The altitude line is a heavy band of clutter produced by radar energy reflected from the surface of the earth. This clutter can cause adverse effects when searching for a target at short ranges. The radar contains circuitry to eliminate the undesirable effects of the altitude line when in the track mode. However, there is no circuitry to diminish or eliminate its harmful effects when in the search mode.

ANTENNA BEAM COVERAGE

F-4B/N

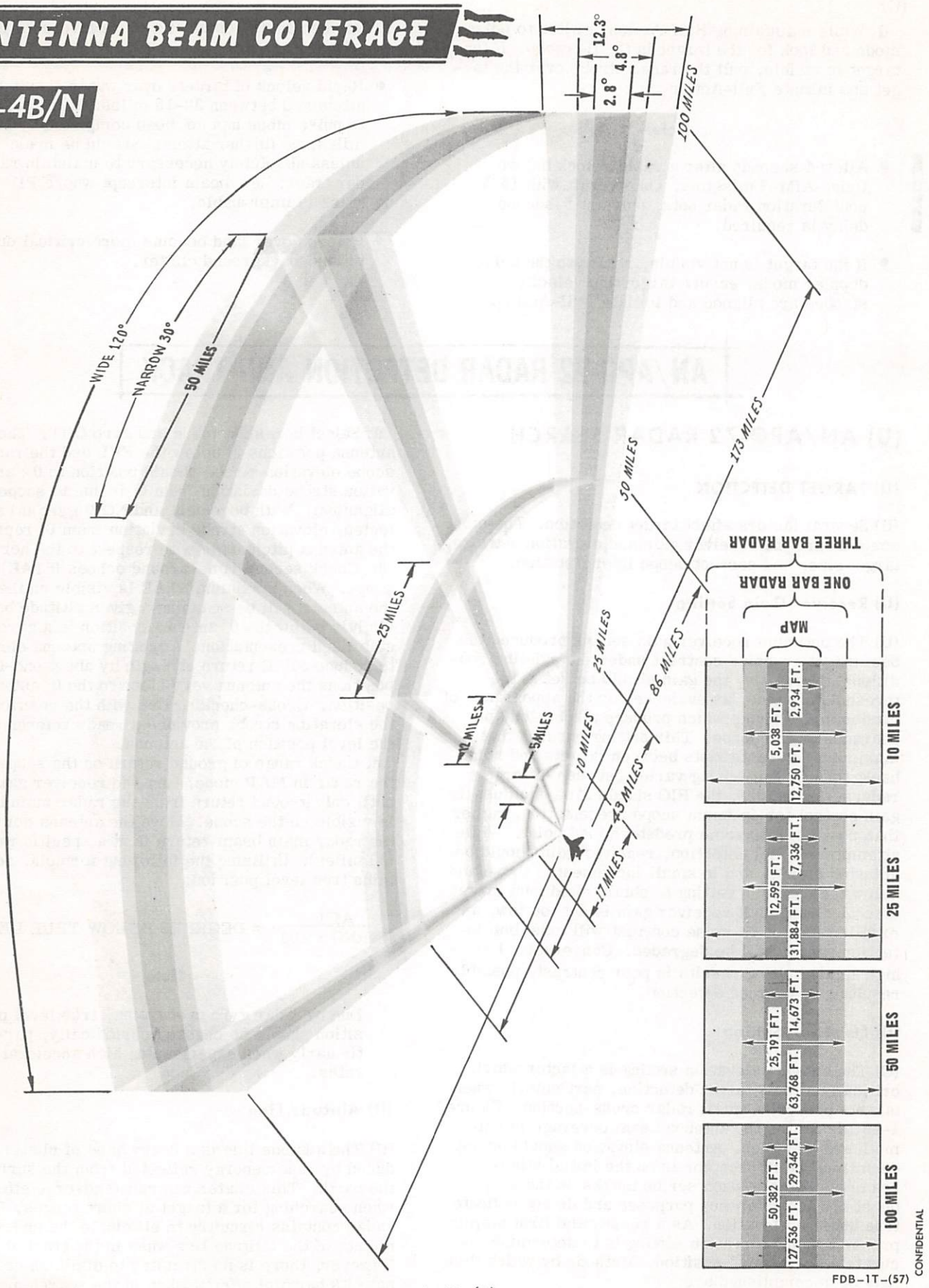


Figure 1-48 (C)

The RIO must accomplish this by proper manipulation of the receiver gain control. Since the target is in the main beam of the radar, and the altitude line is produced by side lobe energy, the target is the stronger return. Therefore, proper gain reduction permits contrast between target and altitude line video.

(U) Weather

(C) Heavy clouds and rain have a serious degrading effect on the detection capability of the radar. In very heavy weather the radar scope will generally be completely saturated and target detection may be virtually impossible, except at very short ranges. The effect is the same as in conditions of effective spot noise jamming. Manipulation of the gain control reduces the effects of the clutter with a corresponding and proportionate effect on the target return. If the clutter switch is ineffective in aiding target detection, the only alternative is to search on the shortest available range scale with continuous manipulation of the gain setting in an attempt to cause the target to burn through the clutter (refer to Secret Supplement, section I, part 8, ECM/ECCM). Burnthrough usually occurs at very short ranges. In marginal weather conditions, degraded target detection is directly proportional to the extent of scope saturation by clutter. There will be some clear areas on the scope and the airplane should be maneuvered to place the target within these areas. If this is not feasible from the tactical situation, it is possible to detect the target in areas where the clutter is less intense. The recommended techniques for target detection in marginal weather conditions are:

a. Persistence and intensity controls to optimum setting.
b. Use wide scan. The contrast between the target and the clutter is more easily discernible in wide scan as opposed to narrow scan. Additionally, the use of narrow scan in clutter conditions requires extremely precise gain setting.
c. Use normal clutter. Heavy clutter results in a reduction of ranging capability and should only be used at short ranges.
d. Use radar mode.
e. Use of the longest effective range scale.
f. Continuous use of receiver gain setting to achieve the greatest contrast between target and clutter video.

(U) Scope Interpretation

(C) Target detection, regardless of relative altitude, is primarily a matter of operator interpretation of the radar scope and knowledge of conditions affecting target presentation on the scope. In a clear environment, free of atmospheric disturbance and countermeasures, target detection is generally dependent upon gain setting and elevation control. At long range, the target appears very similar to a bright background noise spot. As the range decreases, the bright spot becomes brighter in contrast to the noise, gradually expanding in azimuth and range until it appears as a definite target video signal. Accurate air intercept controller information (if available) assists in long range detection since RIO attention can be concentrated on a small portion of the scope. When clutter from atmospheric conditions or land/sea return is present on the scope, target detection techniques must be varied. Long range detection beyond either is possible, but in most cases detection range is decreased because video gain is reduced so that the clutter is sharply defined. The most apparent indication of target presence in clutter conditions is relative motion. The RIO should study each echo which has the characteristics of a target to determine motion which is inconsistent with the clutter return. A difference in relative motion is most noticeable in the forward and rear hemisphere aspects. In the beam, the primary indication of an airborne target is an azimuth change that is inconsistent with ground targets or clutter. The presentation on the radar scope usually varies significantly from intercept to intercept and it is extremely difficult to postulate criteria which will be applicable in the majority of cases. Scope clutter from weather, land/sea return, second time around echoes (STAE), and other targets can cause several problems in target detection, but in many instances clutter can be helpful in determining target presence. The RIO should continually make fine adjustments in elevation and receiver gain to achieve the maximum contrast between the clutter and the normal noise background. If wide sweep is being used for search, the selection of narrow scan to search an area around the azimuth of a suspected target may be helpful. A change in range scale can also assist in detection since it generally results in better contrast between the noise background and the clutter. This is only true when changing to a larger display scale (i.e., shorter range, 50-mile to 25-mile). It is not true when changing to a smaller display scale (i.e., longer range, 25-mile to 50-mile).

(U) LOW ALTITUDE SEARCH OVER WATER

(C) For purposes of this discussion, low altitude search consists of detection of targets flying below 5000 feet. The power output and receiver sensitivity of the AN/APQ-72 and the properties of the direct view storage tube creates extreme problems with sea clutter at low altitudes. In addition, heavier and more dense atmospheric conditions serve to reduce detection ranges. Therefore, the use of proper operating techniques and complete knowledge of the low altitude environment are essential in order to realize the maximum potential of the radar. For example, on any given day, a radar which performs satisfactorily at medium altitude may deteriorate considerably because of the low level environment. The following techniques are recommended:

a. Use of map mode (no nutation). The radar beam scans approximately 7000 feet of altitude at 25 miles. A tangential is established with the surface of the earth beginning at approximately 25 miles. From this point, elevation corrections of about 1° are necessary to detect small targets at ranges commensurate with the prevailing atmospheric conditions. Although some RIO's may prefer the radar mode, it should be pointed out that the main lobe will be considerably broadened, thereby, dissipating some of the

(C)
energy which might better be used for longer range detection. Furthermore, the scope will be more cluttered due to the modulation effects of antenna feedhorn nutation.

b. Intensity and persistence controls at optimum.

c. Receiver gain at the threshold of noise. Ships and land return should be easily discernible beyond the main beam clutter if a proper tangential has been established.

Note

- Refer to Side Lobe Detection (figure 1-47).
- With the antenna properly positioned, very light main beam clutter may begin at about 20 miles. If land return and/or ships are used as references beyond the main beam clutter, the antenna should be elevated so that these are barely discernible. Constant manipulation of the gain control to provide a continuing desirable signal-to-noise ratio is extremely important at low altitude. If the gain is fully clockwise and the scope is dark except for random noise, it may be improperly aligned. In this circumstance antenna elevation setting becomes critical for lack of adequate reference to the surface of the earth. If, however, full gain causes scope flooding, a reduction in gain with readjustment of the persistence and intensity controls may be necessary. Having some control of signal-to-noise ratio without readjustment of the persistency and intensity is optimum.

d. Use of wide scan is recommended due to the limited area covered and background noise buildup in narrow scan. Target information may be marginal.

e. Use normal clutter until the target reaches short ranges (less than 15 miles) undetected. Heavy clutter may then be selected depending upon scope clutter, weather, sea state, etc.

(C) The low altitude airborne target has significant identifying features.

a. An air target appears much smaller than surface targets. In addition, it will probably have a blip-scan ratio of about three to one; therefore, the antenna elevation should be adjusted cautiously.

b. It moves relative to surface targets.

(U) LOW ALTITUDE SEARCH OVER LAND

(C) The radar is considered to have little search capability against low level targets over land. Radar return from the ground effectively saturates the radar scope and usually obliterates any target return. As target altitude is increased and interceptor altitude is decreased, radar detection capability is improved. Detection capability can be further related to the type of land background. Over relatively flat areas, particularly jungle or other relatively poor radar reflective surfaces, radar search is slightly improved. Over valley or mountainous terrain, the radar reflectivity of the land mass is much greater with resultant reduction in radar detection. Radar capability in low altitude search over land is relatively insensitive to operator technique, except to note that in some cases receiver gain setting and elevation control have some effect on detection. The RIO's problem is to detect relative motion between target returns and background clutter. In head-on attacks against large targets, the target appears to be closing faster than the clutter whereas in tail-on attacks, the target appears relatively stationary compared to clutter movement. As the intercept geometry is varied toward the beam aspect, target detection is extremely difficult. In all cases, detection will generally be at a very short range.

(U) AN/APQ-72 RADAR ACQUISITION

(C) Pulse acquisition starts with the selection of Half-Action and terminates when the radar system shifts to automatic track. Prior to acquisition antenna elevation must be adjusted to attain maximum target return. Receiver gain should be adjusted to provide the maximum target contrast with scope background. If three-bar scan has been selected for search, one-bar scan should be selected prior to target acquisition. When the scope is free of clutter target acquisition is relatively simple. However, there are certain procedures which should be followed in order to realize the maximum capability of the radar. When the target has been illuminated in search, employ the following technique:

a. Move the acquisition symbol well below the target.

b. Select Half-Action and spotlight the target in azimuth and elevation.

c. Move the range gate out to the target and select Full-Action. The radar will shift to full automatic track 2 seconds after selecting Full-Action with the target in the range gate.

(U) TIME OF ACQUISITION

(C) There are two basic schools of thought on the proper time, or range, during an intercept when an acquisition attempt should be made, and there are advantages and disadvantages to each proposal. One theory is to delay acquisition until just prior to missile firing range. The other theory is to attempt acquisition as soon in the intercept as possible and to continue acquisition attempts until successful. Several factors must be considered when determining the proper time for target acquisition. These factors are directly related to the tactical situation. A review of expected target capabilities indicates that the advantages of a lockon attempt as soon in the intercept as possible, outweigh the advantages of the delayed lockon technique. Most tactical targets have some sort of warning system to indicate that an air intercept radar is searching or tracking. The targets will not, however, know the range of the illuminating radar. Therefore, a lockon attempt as soon as possible indicates to the target that it has been detected, but, since the target is unaware of interceptor range, it may also prompt the target crew to activate a countermeasure system or use other tactics to disrupt the attack. Invaluable information on

(C)
target capabilities will be available while sufficient range and time are available to vary the situation and/or radar modes to counter target tactics.

(U) MANUAL ACQUISITION

(C) The radar has provisions for acquisition in either a manual or semi-manual mode. To acquire a target in the manual mode, select the manual position on the track switch. Assume manual control of the radar antenna position in azimuth and elevation while manually controlling range and range rate with the manual V_c knob. For acquisition in the semi-manual mode, place the range gate over the target and press the manual V_c knob. The target is tracked automatically in azimuth and elevation as long as the target and range gate remain coincident, but the RIO retains manual control of the range and range rate with the manual V_c knob.

(U) CLUTTER AND LOW LEVEL ENVIRONMENTS

(C) Target acquisition in the presence of clutter can be extremely difficult. The basic procedures for target spotlighting and range strobe positioning apply. The requirement for exact stationary range strobe positioning is of maximum importance in a clutter environment. Since the radar is relatively unlimited in range track acceleration during acquisition and is mechanized to accept the simplest tracking solution with the lowest closing velocity, there is an extremely high probability of locking on clutter if there is considerable movement of the range strobe around the target with Full-Action selected. It is recommended to use map mode at low altitude. However, if target acquisition is unsuccessful, feedhorn run down will aggravate the adverse effects of the clutter and may cause loss of contact with the target. Prior to acquisition, every attempt should be made to maneuver so that the target is separated both in azimuth and range from the clutter and acquisition can be attempted in a relatively clear area. Low altitude target acquisition presents additional problems because the clutter band extends across the entire scope in azimuth. The length of the clutter band in range is almost totally dependent upon the sea state or type terrain, and the elevation setting. In some instances at very low altitude, the main beam clutter may extend out from very close range. The RIO should attempt target acquisition beyond the main beam clutter to reduce the probability of locking on the ground/sea return. If acquisition attempts are unsuccessful and the target enters the main beam clutter, acquisition will be extremely difficult and locks on the clutter should be anticipated. The only alternative available may be selection of heavy clutter. Locks on clutter are less frequent in heavy clutter because of the narrow (0.4 microsecond) range tracking gate in this mode. However, target spotlighting is more difficult than with normal clutter selected. AOJ OUT should be selected during all low level lockon attempts to preclude AOJ operation in the radar. A range lockon to a clutter signal will be immediately indicated to the RIO by a near maximum opening or closing range rate display with accompanying rapid range strobe movement in range and downward antenna movement to follow the clutter.

(U) PILOT LOCKON MODIFICATION (PLM)

(C) The pilot lockon modification (PLM) supplements and enhances the capabilities of the AN/APQ-72 radar system. If the RIO is unable to acquire and lockon a target in an ACM environment due to high G forces or any one of many factors, the pilot has the capability to acquire a target and launch an AIM-7 missile.

(C) PLM on F-4B without VTAS is utilized as follows: NEW

a. The pilot visually boresights the target.
b. The pilot presses the nose wheel steering button.
c. The radar switches to boresight, heavy clutter, and 5-mile scale.
d. The range gate sweeps in from 5 miles to 1/4 mile or out from 1/4 mile to 5 miles, dependent upon the position of the sweep select switch (IN/OUT) on the Bullpup panel.
e. As the range strobe sweeps through the target, the radar automatically acquires the target and switches to full system track.
f. If acquisition does not occur, the range gate will continue to sweep in the direction selected until the target is acquired or the nose wheel steering button is released.

(C) PLM on F-4N and F-4B with VTAS is utilized as follows: NEW

a. Track switch - AUTO
b. Sweep select switch - AS DESIRED
c. VTAS mode switch - SEAM/PLM
d. Missile select switch - RADAR
e. Pilot boresights target.
f. Press TAE to Half-Action. The radar switches to boresight - heavy clutter - 5-mile scale.

(C) For automatic lockon:

g. Press TAE to Full-Action. The range strobe sweeps in from 5 miles to 1/4 mile or out from 1/4 mile to 5 miles, dependent upon the position of the sweep select switch (IN/OUT) on the Bullpup panel.
h. As the range strobe sweeps through the target, the radar automatically acquires the target and switches to full automatic track. The TAE may be released.
i. If acquisition does not occur, the range strobe continues to resweep in the direction selected until the target is acquired or until the TAE is released.

Note

For automatic lockon, the target TAE may be pressed immediately to Full-Action after the target is boresighted. Range gate sweep and radar lockon are not enabled until the antenna is within 3° of boresight.

(C) For manual lockon:

j. After target is boresighted, pilot presses TAE to Half-Action and holds; RIO presses action switch on antenna hand control to Half-Action to obtain manual control of range gate.

k. Move range strobe over target in B-sweep with antenna hand control and press action switch to Full-Action to lock radar on target.

l. When radar lockon is achieved, TAE and action switch may be released. Radar automatically range and angle tracks target.

(C) On all F-4B/N, target or altitude line lock rejection can be initiated by either pressing the nose wheel steering button (momentarily pressing TAE to Full-Action with VTAS) or having RIO select Half-Action on the antenna hand control.

Note

- PLM is activated upon pressing the nose wheel steering button or TAE if the AN/APQ-72 is operating in any condition other than manual track, an AI range is selected, and RDR, MAP, or BST is selected.
- PLM cannot be activated during autopilot operation.
- PLM limits the radar to back bias operation.

(U) VTAS/RADAR MODE ACQUISITION

(C) With VTAS, the pilot is provided with an integrated system that combines the features of the pilot lockon modification with that of a helmet sight. The pilot can visually acquire the target and lock the radar on the target by operating a single, control-stick-mounted switch. VTAS eliminates the requirement for accurate target tracking through the gunsight. Provided the radar power switch is in OPR, an AI range is selected, the track switch is in AUTO, the radar mode switch is in RDR, MAP, or BST (after AVC 679), and the range gate sweep direction is selected with the sweep select switch, target designation and acquisition is accomplished as follows:

a. VTAS mode switch - VTAS
b. VTAS power switch - ON
c. Missile select switch - RADAR
VTAS/RADAR mode discrete light illuminates
d. Look at target and center it on the helmet sight reticle.
e. Press TAE to Full-Action for automatic lockon. Radar antenna slaves to pilot's line of sight and 5-mile range is automatically selected.

Note

- Helmet sight reticle blinks if pilot's line of sight angular displacement from boresight exceeds radar antenna slaving limits.
- Reticle extinguishes if pilots helmet is not within sensor surveying unit coverage envelope (approximately ± 75°).

f. Radar range gate automatically sweeps in from 5 miles toward 1/4 mile or out from 1/4 mile toward 5 miles (dependent upon the position of the sweep select switch on the Bullpup panel) in attempt to acquire target.

Note

Keep the target centered on the reticle until lockon is achieved.

g. When the radar lockon discrete light (lower right light) illuminates, TAE may be released. Radar automatically range and angle tracks target.

(C) If a manual VTAS/RADAR mode lockon is desired:

h. After target is centered on the helmet sight reticle, pilot presses and holds TAE in Half-Action. RIO presses action switch to Half-Action to obtain manual control of range gate.

i. Move range strobe over target in B-sweep with antenna hand control and press action switch to Full-Action to lock radar on target.

j. When radar lockon occurs, TAE and action switch may be released. Radar automatically range and angle tracks target. Radar lockon discrete light illuminates and VTAS/RADAR mode discrete light extinguishes unless pilot's line of sight remains within 3° of radar antenna look angle.

k. To visually reacquire target being tracked by radar, note antenna position from scope indications and visually scan this area of space. VTAS/RADAR discrete light (upper right light) illuminates when pilot's line of sight is within 3° of radar antenna look angle. Target should be along this line of sight.

(C) Target lockon may be rejected by momentarily pressing TAE to Full-Action or the action switch to Half-Action. When lockon is rejected, the radar returns to the mode and condition of operation it was in prior to lockon initiation.

Note

Wait 4 seconds after a VTAS/RADAR mode lockon before firing an AIM-7 missile. When the dogfight computer is installed, the SHOOT light flashes approximately 4 seconds after a VTAS/RADAR mode lockon if within the computed ACM launch zone for a maneuvering target. Refer to F-4B/N and F-4J Firing Delay, this section.

(U) AN/APQ-72 RADAR TRACK

(C) The radar has provisions for four primary target tracking modes:

Automatic track
Manual or semi-manual track
HOJ track
AOJ track

(C) HOJ and AOJ track are discussed in detail in Secret Supplement section I, part 8, ECM/ECCM.

(U) AUTOMATIC TRACK

(C) Automatic target tracking commences 2 seconds after target acquisition in the automatic mode. During this tracking mode the radar tracks the target automatically in range, azimuth, and elevation without any requirement for RIO inputs. The RIO must, however, monitor the radar to ensure that target track is maintained, and be prepared to reacquire the target if the track should break or lock should transfer to another target. Indications of track break, an impending lock break, or a lock transfer are irregularities in the V_c gap, R_a and R_{min} strobes, the range tracking light, and the B-sweep. When the radar is stabilized in steady track, the position of the V_c gap and the R_a and R_{min} strobes will remain constant and the range tracking light will be steadily illuminated. If the V_c gap starts to oscillate and the R_a and R_{min} strobe positions jump in and out, the indication is that the radar range track is erratic. The range tracking light should then be monitored in addition to the other indication. If the light is blinking, range track is intermittent and the radar may break lock. If the light goes out for 2 to 3 seconds, the system is tracking in range memory. The RIO should select Half-Action and reacquire the target. The range tracking light may extinguish without changes in range rate or R_a/R_{min} strobe position. This is again indicative of a shift to range memory and the target should be reacquired. Unanticipated B-sweep movement in azimuth, with or without an elevation strobe change, indicates a break in angle track. If the B-sweep azimuth changes and the range tracking light remains illuminated, the radar is tracking a target. Range rate and R_a/R_{min} strobe position should indicate the nature of the target. If all indications are normal, the target has probably turned. If B-sweep azimuth changes and the range tracking light extinguishes, the system has probably lost angle track and will break lock after the expiration of the 5 to 7 second range memory tracking time. The RIO should select Half-Action and reacquire the target. If the target is acquired in normal clutter, the radar will shift to heavy clutter after 2 seconds of track and when the target is sufficient strength for tracking in the back bias receiver (Power Level Mode Switching - PLMS). If the radar is not calibrated correctly, PLMS may be premature and occur before the target is strong enough for back bias receiver tracking. In this case, the radar will break lock after the expiration of the range memory tracking time. The RIO can overcome this deficiency by selecting clutter override until the range has decreased to the point where tracking in back bias is possible (usually 20-25 miles), then select normal clutter, or delay further lockon attempts until the range has closed to 20-25 miles. Another cause for lock breaks immediately following PLMS is a malfunction in the back bias receiver tracking circuits which precludes range track in heavy clutter. The occurrence of this problem is similar to a lock break because of premature PLMS and it can be overcome only by selecting override on the clutter switch. The RIO should be prepared for rapid target reacquisition in the event of a lock transfer or a break lock. Immediately after stabilized automatic track is indicated, the following switch positions on the radar set control should be selected:

Scan	1-BAR
Sweep	WIDE
Mode	RADAR
Receiver gain	For normal search

(C) The radar is then reset so that the RIO can take rapid action to reacquire the target.

(C) On aircraft with the dogfight computer, the dogfight computer launch zone computations are always displayed by the SHOOT light and the gunsight reticle when a missile is ready for firing and the target is in range. When DOGFIGHT is selected with the missile interlock switch, the dogfight computer also controls the following displays on the radar scopes: R_a and R_{min} strobes, break X, and IN RNG light.

Note

The R_a and R_{min} strobe positions will probably change if the pilot manually selects the AIM-7E-2 dogfight mode during automatic track. This is caused by a shift from target intercept computer solutions to dogfight computer solutions (maneuvering target launch zone computations).

(U) Altitude Line

(C) The radar has automatic features to eliminate the adverse effects of the altitude line in the track mode. They are primarily centered in range tracking acceleration limits in the back bias receiver. In this mode, the radar does not accept range rate changes in excess of 114 feet per second/per second (3.5 G). Therefore, the radar will normally track a target successfully through the altitude line regardless of attack aspect. The radar is susceptible to transfer of lockon to the altitude line when tracking in the narrow band receiver because of the wide (2.0 microsecond) range tracking gate. The probability of lockon transfer is inversely proportional to the closing velocity; i.e., lowest at high closing velocities and highest at low closing velocities.

(U) Elevation Strobe

(C) In the automatic tracking mode the elevation strobe is a relative altimeter which can be used to determine the target altitude in relation to the interceptor. A convenient rule-of-thumb which provides target relative elevation is to multiply degrees in elevation X range X 100. Elevation difference is in terms of feet; i.e., 2° elevation X 25 miles range X 100 equals 5000 feet above the interceptor altitude. The elevation strobe can be of considerable assistance in determining target flight characteristics. A rough indication of relative target elevation can be ascertained by switching to HEAT in straight and level flight and noting aim dot position.

(U) MANUAL AND SEMI-MANUAL TRACK

(C) For full manual track, the range strobe should be maintained about 1 mile behind the target in range with range rate adjustments as required. Manual gain control is required in full manual track in addition to manual inputs of range, range rate, azimuth,

(C)
and elevation. At ranges beyond 25 miles, manual tracking is relatively easy despite large elevation differences and changing azimuth. Inside 25 miles, manual track becomes significantly more difficult, particularly with azimuth or elevation changes. It is recommended that intercept geometry be stabilized, particularly in altitude, and manual tracking commenced at ranges of 15 miles or less. For satisfactory AIM-7 launch, the target track in azimuth must be smooth without abrupt azimuth changes which can cause large aim errors in the AIM-7 at launch and preclude successful missile operation. The altitude line presents a problem because receiver gain must be reduced to maintain contact with the target. This can be eliminated and contact retained with the target if the RIO maintains steady track while reducing gain as the target approaches the altitude line. Since the altitude line is a side lobe return and the target is in the main beam, video gain can be reduced to the point where the altitude line effectively disappears but the target is still visible. Care should be taken with this technique, however, since with a very high gain reduction, the target can easily be lost while it is traversing the altitude line. Semi-manual track is not recommended for most tactical situations. Full manual track is a more reliable tracking mode since the target is visible at all times.

(U) TRACKING IN CLUTTER ENVIRONMENT

(C) The radar is susceptible to break locks or lock transfers to clutter in all conceivable tactical environments. This susceptibility is not easily defined except to note that the probability is higher as the clutter increases. There have been no recorded instances of lock transfer to STAE. Break locks or lock transfers to weather clutter are very common, particularly when the target is operating in or very close to the weather. In low level intercepts, lock breaks and transfers to ground/sea clutter should be anticipated. This is especially true over water when the target flies over surface contacts. Once automatic track has been established, the RIO has no control over the tracking features of the radar. The only precautions which can be taken are close monitoring of the attack presentation and effective fast lockon technique to accomplish a rapid relock if the radar shifts or breaks lockon. In most tactical situations, a properly calibrated radar has a fair probability of successful tracking if lockon is accomplished in a clutter free area and PLMS has occurred before the target enters the clutter.

F-4B/N AND F-4J AIM-7 FIRING DELAY

(U) RADAR/SPEEDGATE SETTLING TIME

(C) A 4-second delay from radar acquisition to trigger squeeze is required to assure with high confidence that the AIM-7 missile speedgate is positioned around the correct simulated doppler frequency. If an AIM-7 missile is committed before the 4-second delay, the possibility exists that the missile will fail to acquire the correct target doppler and subsequently go ballistic. This 4-second delay is caused by radar settling time (time from initial acquisition to full system track) and speedgate settling time (time required for simulated doppler signal to build up to correct frequency and for missile speedgate to acquire this signal). Radar settling time is built into the radar and is 2 seconds for the AN/APQ-72 system and 1.5 seconds for the AN/APG-59 system. Speedgate settling time is a combination of time for the speedgate to break lock on quiescent doppler (0.3 second) and time for the speedgate to lock on true simulated doppler (normally 1.5 seconds). On F-4J with 1527 configuration radar sets, only a 1.5-second delay from radar acquisition to trigger squeeze is required. On these aircraft, settling times are reduced. Also, if the high-G switching command is enabled, full track occurs 0.63 second after range lock instead of 1.5 seconds.

(C) In F-4J that do not have 1527 configuration radar sets, when V_C is greater than the interceptor true airspeed (forward quarter), the simulated doppler signal being supplied to the AIM-7 missile may not be within the ± 5 kHz sweep limits of the missile speedgate until 6 seconds after initial lockon. In this case, the recommended minimum 4-second time delay between initial lockon and trigger squeeze may result in an unsuccessful launch. Delaying trigger squeeze an additional second for forward quarter shots satisfies this constraint.

Note

- On F-4B/N and F-4J with radar sets other than the 1527 configuration, the previously mentioned time delays require the pilot to wait 4 seconds from the time the RIO goes to Full-Action when acquiring the target or 4 seconds from the time the range gate stops on the target in a PLM or VTAS acquisition before launching the AIM-7. If a rapid relock to the pulse mode is initiated, the time delay is reactuated. It therefore behooves the RIO to initiate the rapid relock as soon as practical. On F-4J with 1527 configuration radar sets, the time delay functions are similar except that the delay is only 1.5 seconds.
- In pulse doppler mode, velocity acquisition is accomplished in 0.4 second. In PD allow a total of 2.2 seconds from initiation of Full-Action to AIM-7 firing.

(C)

- The cw power switch must be turned on early in the flight to check missile status since in the F-4J, a 100-second delay is built in the system before cw transmissions. Leave the cw power switch in a standby status after missile checks to reduce possible cw failures and to keep the missile in a warmed up status.

- On F-4N, F-4J 155844aj and up, and all other F-4B/J after removal of pseudo tuning, the SELECTED/SP and READY lights can be monitored to determine when the firing delay has been satisfied. The lights will go out when the speedgate breaks lock on quiescent doppler and will illuminate when the speedgate acquires simulated doppler. When using this procedure, however, the pilot should wait about 1 second after the lights illuminate before launching the AIM-7 missile. This ensures that the speedgate has not momentarily locked on the simulated doppler before it has completely settled.

(C) On F-4N, F-4J 157261ao and up, and all other F-4B/J after AFC 476, the probability of speedgate lockon after missile launch has been improved by the installation of a 0.52 second delay relay in the missile sweep select circuits. On F-4B and F-4J thru 155843ai before removal of pseudo tuning, the speedgate immediately goes into narrow sweep when the trigger is pressed. If the speedgate is not locked on the simulated doppler, the missile is launched probably not knowing the true simulated doppler. After AFC 476, however, the 0.52 second delay relay delays the narrow sweep command and allows the speedgate to sweep in wide sweep for an additional 0.52 seconds after trigger squeeze, thus increasing the probability of speedgate lockon. On F-4N, F-4J 155844aj and up, and all other F-4B/J after removal of pseudo tuning, the missiles cannot be fired untuned (speedgate not locked on simulated doppler); however, it is possible to fire the missile during a momentary speedgate lock (speedgate locks on, then breaks lock due to simulated doppler settling action). Squeezing the trigger during the momentary lock immediately commands the narrow sweep. If the simulated doppler settles to a frequency beyond the narrow sweep frequency range (± 5 kHz), the missile will be launched not knowing the true simulated doppler. After AFC 476, however, the delay relay inhibits the narrow speedgate sweep command for 0.52 seconds after trigger squeeze, thus enhancing the probability of speedgate lock on the true simulated doppler frequency.

Note

On F-4N, F-4J 155844aj and up, and all other F-4B/J after removal of pseudo tuning, untuned AIM-7 missiles selected for firing are automatically stepped over at trigger squeeze and trapped out of the firing sequence. On F-4B/N and F-4J before cockpit optimization, trapped out missiles that tune may be immediately reset into the sequence by cycling the missile arm switch. They are automatically reset into the firing sequence when a fire signal is supplied to the last missile station in the normal firing sequence (right aft fuselage, aircraft station 7). Under some circumstances, the trigger may have to be pulled twice to automatically reset and fire trapped out missiles that tune. On F-4J with cockpit optimization, trapped out missiles that tune may be immediately selected with the weapon select switch. As on other aircraft, they are automatically reset into the firing sequence when a fire signal is supplied to the last missile station in the normal firing sequence.

VISUAL TARGET ACQUISITION SET

(U) DESCRIPTION

(C) VTAS enables the pilot to designate targets for either the radar or an AIM-9G/H missile seekers via a helmet sight. VTAS operation is controlled mainly by the target acquistion enable (TAE) switch on the control stick. With the VTAS mode selected and VTAS power ON, pressing the TAE to Half-Action slaves either the radar antenna or the selected AIM-9G/H seeker head to the pilot's line of sight through the VTAS helmet sight reticle. If RADAR is selected with the missile select switch (F-4B/N) or SP/GN is selected with the stick grip weapon select switch (F-4J), the radar antenna slaves to the pilot's line of sight. If HEAT (F-4B/N) or SW (F-4J) is selected, the selected AIM-9G/H seeker slaves to the pilot's line of sight. Other AIM-9 seeker heads remain at boresight. Pressing the TAE to Full-Action commands the sensor being slaved to lock on the designated target.

(C) The helmet sight reticle forms an aiming reference for the pilot and it is also utilized to indicate nonoperating conditions. The reticle extinguishes if the pilot moves his head out of the allowable head motion box thus denying helmet position information to the VTAS computer. The helmet sight reticle blinks whenever a sensor (radar antenna or AIM-9G/H seeker) is being commanded to slave (Half-Action or Full-Action) beyond its acquisition limits (60° from boresight for the radar; 22° from boresight for the AIM-9G/H seeker). In this case, the sensor stops at its limit in the commanded direction and remains there until commands within its acquisition limits are again received.

(U) Before flight the VTAS must be calibrated. Refer to the NATOPS Flight Manual for preflight calibration procedures. Before turning VTAS power ON, ensure VTAS mode is selected or calibration cannot be conducted.

Note

If VTAS power is turned ON with the mode switch in SEAM/PLM, the power switch must be cycled OFF, VTAS selected, and the power switch returned to ON.

(U) Airborne VTAS checks are also required to ensure proper operation. The airborne check is accomplished by utilizing VTAS to slave and lock the radar on targets at varying degrees off boresight.

AN/APX-76A INTERROGATOR EQUIPMENT SET

(U) DESCRIPTION

(C) The interrogator equipment set AN/APX-76A, in conjunction with the aircraft radar system, provides air-to-air IFF capabilities. The set transmits coded interrogations in synchronization with the transmitted radar pulses to challenge modes 1, 2, and 3 IFF transponders directly along the radar electrical boresight line. Correct selective identification feature (SIF) replies from the interrogated aircraft are received, decoded, and processed to provide a visual display on the radar scopes (F-4B/N after AVC 664; F-4J with 1413 configuration and later configuration radar sets and all other radar sets after AVC 750). Interrogation signals consist of pulse pairs, with proper spacing between pulses dependent upon the mode of operation. Transponders aboard friendly target aircraft, operating on the selected mode, accept the pulse pair and respond by generating a coded reply on a frequency of 1090 MHz. The indication of a correctly coded response is a double video slash that brackets the target on the radar scope. Incorrectly coded responses result in a single video slash below the radar target. In order to provide identification of only those aircraft within a limited antenna pattern, the effective beamwidth of transmitted and received signals is narrowed by the use of interrogation and receive side lobe suppression circuitry.

(U) Interrogator Set Control Panel

(C) The interrogator set control panel is in the rear cockpit. Switches and indicators on the control panel include the following:

a. The TEST-CHALL CC switch is three-position, center-return toggle switch. In CHALL CC, a maximum 8 second interrogation-reply period is initiated. The time of interrogation is determined by the duration of time the switch is held in this position. In TEST, a loop test is initiated in which the interrogator set is permitted to interrogate the aircraft's own transponder.

b. Mode selector. The mode selector thumbwheel switch has six positions: 1, 2, 3, 4A, 4B, and white (standby). The selection of one of these positions determines the mode of system operation.

Note

For mode 4 operation, an interrogator computer must be installed in the nose wheel equipment bay. It is not required for modes 1, 2, and 3. Provisions for installation of the computer are provided on F-4N, F-4B after AFC 352, F-4J thru 155528ag after AFC 388, F-4J 155529ag thru 155843ai after AFC 415, and F-4J 155844aj and up.

c. Code selectors. Four thumbwheel digital selectors, each having eight positions, are used for setting the reply code required for a correct decode indication.

d. Mode 4 (M4) noise alarm override switch. This switch allows the noise alarm of the interrogator computer to be overridden and clears one possible type of fault indication during mode 4 operation.

e. CHALL and FAULT indicators. The CHALL indicator illuminates during an interrogation-reply period if the equipment performance monitor circuitry determines operation is satisfactory, otherwise the FAULT indicator illuminates.

(U) Challenge Enable Button

(C) The challenge enable button is on the radar antenna hand control. The button is a push-button switch which initiates an 8 second (maximum) challenge period, determined by the duration of time the switch is pressed. This button is similar to the CHALL CC switch on the interrogator set control panel, except the challenge enable button allows replies not correctly coded to be displayed on the radar scopes.

(U) IFF Audio Control Knob

(U) This knob is on the emergency floodlights panel in the front cockpit. The knob controls the 400 Hz tone present during a challenge period. The tone informs the pilot that IFF markers may be present on the radar scope.

(U) IFF Ground Test Switch

(U) The IFF ground test switch is on the overheat control panel in the rear cockpit. The switch, when placed to IFF GRD TEST, permits ground operation of the interrogator set by bypassing circuitry provided to inhibit inadvertent ground operation. If ground power is interrupted, the switch returns to NORMAL.

(U) Fault Indicators

(C) On F-4J 155793ai and up, F-4J thru 155528ag after AFC 388, and F-4J 155529ag thru 155792ai after AFC 453, fault lights for the AN/APX-76A interrogator set are provided on the No. 1 circuit breaker panel. They include the RCVR-XMIT (re-

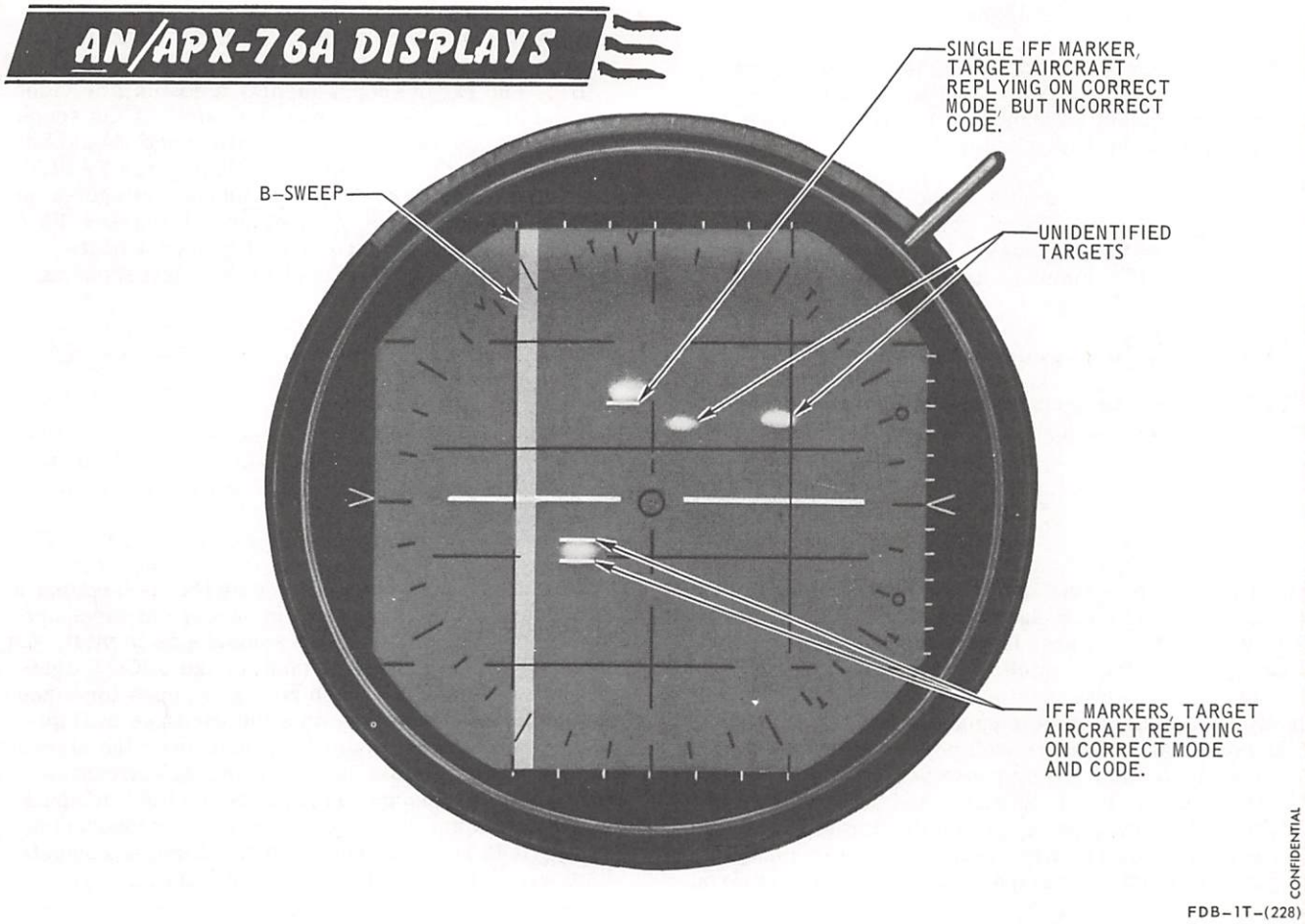


Figure 1-49 (C)

(C)

ceiver-transmitter) fault light and the SW-AMPL (switch-amplifier) fault light. The receiver-transmitter fault light monitors the video circuits, receiver side lobe suppression circuitry, transmitter power, modulation trigger pulses, and the receiver-transmitter power supply. The light illuminates when a malfunction is detected. The switch-amplifier fault light monitors the output to the difference antenna, the output to the sum antenna, the interrogation input to the switch-amplifier, the interrogation side lobe suppression gate, and the switch-amplifier power supply. The switch-amplifier light illuminates when a malfunction is detected.

(U) AN/APX-76A INTERROGATOR SET OPERATION

(C) The interrogator set is energized when the radar set control power switch is set to any position other than OFF. For mode 1, 2 or 3 operation, position the mode thumbwheel to the desired mode; also position the code thumbwheels to the predetermined code for the particular mode. For mode 4 operation, set only the mode thumbwheel to the desired position. To initiate interrogation, either press the challenge enable button on the antenna hand control or position the TEST-CHALL CC switch to CHALL CC (challenge correct code). Either procedure initiates an 8 second maximum challenge period. The length of the period is determined by the duration of time either switch is held in position (8 seconds maximum). Video displays are then presented on the radar scopes. Radar target displays of aircraft that respond to interrogation with the correct code are bracketed by two video markers. The markers are 1 mile apart when the range selected on the radar set control is 50 miles or less. The markers are 2 miles apart when the range selected is greater than 50 miles. The lower marker only may be displayed in modes 1, 2 or 3 if the challenge enable button is utilized to initiate the challenge. These targets are replying on the correct mode but the incorrect code. Both markers are displayed when the proper code, as set on the interrogator set control panel, is being received. No markers are displayed when the mode received is incorrect (challenge enable button interrogation) or when the code received is incorrect (TEST-CHALL CC switch interrogation). Correct response to mode 4 interrogation is also indicated by two markers bracketing the target but an incorrect mode or code response to mode 4 interrogation results in no IFF markers being displayed regardless of the switch utilized to initiate the interrogation. Refer to figure 1-49 for an example of IFF marker displays.

Note

- IFF markers may appear on the radar scopes with no target video present because the interrogator set antenna patterns extend above and below the radar beam.
- When the F-4J radar is in the PD search mode, the IFF markers coincide with the associated velocity target in azimuth only since the IFF markers are still displayed as a function of range.

(U) AN/APX-76A System Loop-Test

(C) To provide an operational test of the system, set the mode and code of the IFF transponder set control panel to the same mode and code selected on the interrogator set control panel. With the radar set operating, position the TEST-CHALL CC switch to TEST. The radar scopes display a double line video presentation extending across the width of the scope face at a range of 4 miles (10-mile range should be selected). During the initial challenge, the FAULT light may illuminate. The light should extinguish on subsequent operations. Any other IFF marker displays that may be present are displaced 4 miles farther in range with respect to the corresponding radar target.

PART 3 WEAPONS SYSTEM

(C) This part presents the performance capability of the F-4B/N and the F-4J weapon system. The objective in aerial combat is to maneuver the aircraft into a position from which the armament can be brought to bear with maximum effectiveness. This position is dictated by the capability of the armament. The permissible firing envelope for the selected armament is determined by range velocity (V_c), track crossing angle (TCA), altitude, and launch heading error. This envelope is extremely distorted by target maneuvers. The fire control computer cannot define the missile envelope in a maneuvering environment. Therefore, when employing the F-4 against a maneuvering enemy fighter, knowledge of the shape and dimensions of the missile envelopes is vital. On aircraft with a dogfight computer, the SHOOT light indicates AIM-7E-2 launch zone envelopes for maneuvering targets; however, this indication is still dependent on the pilot's ability to maneuver the aircraft into a position for maximum weapon effectiveness. Because of the inaccuracies of the dogfight computer AIM-9 minimum range solutions for a maneuvering target, it is recommended that the dogfight computer displayed AIM-9 solution not be utilized.

SYSTEM MALFUNCTIONS

(U) RADAR MALFUNCTION

(C) A radar malfunction may adversely affect AIM-7 missile performance. AIM-9 launches are not affected by radar malfunctions. The only malfunctions that completely preclude AIM-7 utilization are english bias, head aim, or no SELECT light. In the AN/APQ-72, english bias is checked in BIT 5 and head aim is checked in BIT 2. In the AN/APG-59 with the 1.5 or 1.6 test tape, english bias is checked in frames 33 and 34, and head aim is checked in frame 12.

(U) Transmitter Monitoring

(C) On F-4J aircraft, pulse radar transmission while the aircraft is on deck is possible. With the cw transmitter OFF and one of the pulse modes selected, selecting OPR with the function switch allows verification of transmitter operation.

(C) Since no transmitter monitoring meter is provided in F-4J aircraft, the possibility of a radar transmitter failure while airborne may be difficult to detect in an expedient manner. Three methods for determining the possibility of a transmitter failure are as follows:

a. Switch to pulse mode and check for an altitude line. If no altitude line is present nor any clutter when the antenna is depressed, then the radar transmitter has probably failed.

b. In the pulse doppler mode, a pitch change in the headset can sometimes be heard when the radar set control function switch is cycled between STBY and OPR. In addition, spurious horizontal "birdies" may appear on the scope during the switch cycling procedure. This unwanted noise is the result of radar energy striking the waveguide switch as it is rotating. The absence of the aural tone pitch change or the horizontal strobes (birdies) are not positive indications of a transmitter failure.

c. Cycling the function switch to TEST and back to OPR in the PD wide scan search mode calls up a synthetic 213 knot left to right wind and the MBC notch shifts off center. If the notch fails to re-center after returning to OPR, the most probable cause is a transmitter failure. If the Nav Comp mode is selected on the BDHI a clutter lock will be indicated by movement of the No. 2 needle.

(U) High voltage power supply overloads in the radar or cw transmitters may cause the transmitters to be inoperative. On F-4B/N, the radar transmitter overload circuits can be reset by cycling the radar power switch to STBY and back to OPR. On F-4J, the over-

load circuits in both the radar and the cw transmitter can be reset by cycling the radar function switch to STBY and back to OPR. On F-4J after IAVC 873, the overload circuits are reset by momentarily positioning the radar set control scan control knob to B PLUS OFF XMTR RESET.

(U) Boresight Mode

(C) The boresight mode is an additional method of launching the AIM-7 missile and is utilized when a radar malfunction precludes target tracking and cw power is available. The pilot calls for boresight as the bogey moves into the gunsight (reticle depressed to 35 mils). The bogey must be tracked within 25 mils of the pipper until missile impact. Prior to launch, the pilot must estimate range by target size in the sight (refer to Visual Estimation of Range, this section). The RIO must properly position the target aspect switch (F-4B/N only) utilizing pilot bogey information.

Note

- Boresight shots should only be used as a last resort due to the difficulty of maintaining cw illumination and the lack of a true simulated doppler for the missile speedgate.
- If the AIM-7E missile is fired in the PD boresight mode without lockon, range arming of the missile occurs late. Late range arming affects the missile kill probability if it is launched near minimum range.

(C) In the AN/APQ-72, use of the target aspect switch improves the capability of the AIM-7 in the low altitude environment. Firing the AIM-7 in the conventional boresight mode at low altitude will probably result in the missile locking on ground clutter. The basic problem is caused by the missile being launched in WIDE speedgate sweep. Basically, the target aspect switch permits the AIM-7 to be launched in narrow sweep with the AI radar in boresight. The speedgate is positioned about one of four closing velocities set by the RIO. These closing velocities are chosen depending on target speed and aspect, and consist of aircraft true airspeed plus or minus a constant speed. Until the target aspect switch is installed, all firings against low altitude targets should be made in full system, if at all possible. It is difficult to obtain AI radar detection and lock on low altitude targets. The aircraft should descend as low as possible to obtain lock, even at the expense of delaying fire. Even if lock can be obtained co-altitude or with look-down, it is advisable to descend as low as possible. This enhances the probability of missile speedgate lock and reduces the possiblity of early fuzing due to target fades. Low altitude boresight firings are not recommended.

Note

In boresight, steady turn rates must be used to provide proper head aim to AIM-7 missiles.

(U) AIRCRAFT SYSTEM MALFUNCTIONS

(U) Electrical

(U) In the F-4B/N if a generator failure trips the radar off the line, the RIO may use EMER to regain immediate use of the radar when electrical power is restored (except for 30-second delay for scope display). On F-4J, selecting EMER does not bypass the radar time delay. Therefore, the 4.5-minute warm-up period must be satisfied before radar operation is restored. On F-4B and F-4J through 155843ai before removal of pseudo tuning, the pilot should recycle the missile arm switch to check AIM-7 retune. On F-4N, F-4J 155844aj and up, and all other F-4B/J after removal of pseudo tuning, AIM-7 retune can be monitored with the missile arm switch in ARM. On F-4J with cockpit optimization, an electrical power interruption will deenergize the weapon relays causing all weapon status lights to go out. After electrical power is restored, the desired weapon must be reselected to obtain status lights. AIM-9 capability is available on all aircraft immediately after electrical power is restored. However, on aircraft with weapon status lights out, the weapon select switch on the control stick must be pressed to SW. On F-4B/N and F-4J without cockpit optimization, the Sidewinder coolant switch must be re-engaged.

(U) Utility Hydraulics

(U) Erratic antenna drive is the first indication of a utility hydraulic failure. Automatic track capability also degenerates. Use boresight mode if some hydraulic pressure is available. If a total utility hydraulic failure occurs, the antenna will droop under G and no AIM-7 capability will be available. AIM-9 capability is unaffected.

(U) Radar CNI Cool Off Light

(U) With the RADAR CNI COOL OFF light illuminated, the radar is cooled by ram air. The RIO may use EMER to bypass temperature interlocks if the radar trips off due to overtemperature.

CAUTION

EMER should only be used to bypass temperature interlocks when equipment damage is subordinate to mission completion.

(U) SPC Failure

(U) With an SPC failure, avoid the transonic region (0.9 - 1.1 Mach) and fire the AIM-7 only if necessary or in optimum position. AIM-9 capability is unaffected.

(U) Air Diverter Valve Failure

(U) On F-4J 155875al thru 158354as and all other F-4J after AFC 463, an air diverter valve is installed in the air inlet duct of the liquid coolant heat exchanger. It diverts additional cooling air to the radar package in the nose during pulse operation on

the ground to reduce overtemperature failures. A RADAR COOL DIV CLOSED light on the telelight panel illuminates when the valve is closed and diverting additional cooling air to the nose package. During any other mode of radar operation (standby, B+ power removed, PD operation, or CW operation) on the ground and during any mode of radar operation in flight, the diverter valve remains open (does not divert cooling air to nose package). The RADAR COOL DIV CLOSED light should not illuminate in flight, but if it does illuminate, select a low heat mode; i.e., discontinue CW operation and select any mode but PD. NEW NEW On F-4J 158355at and up, the radar cooling system is modified to provide sufficient ground cooling. On these aircraft the RADAR COOL DIV CLOSED light is replaced by a RADAR LIQ COOL OVERHT light. If this light illuminates in flight, select a low heat radar mode.

(U) MISSILE MALFUNCTION

(U) Select Light Malfunction

(U) On F-4B and F-4J through 155843ai before removal of pseudo tuning, if a blinking SELECTED light is encountered, arm to trap the light out. This traps out the bad missile. After firing the good missiles, recycle and arm with the blinking light on. NEW The bad missile may guide when launched. On F-4N, F-4J 155844aj and up, and all other F-4B/J after removal of pseudo tuning, a missile with a blinking SELECTED light cannot be trapped out by arming when the light is extinguished because the missile tuning function continues after arming. However, this missile can be trapped out when it is selected for firing by squeezing the trigger when the SELECTED light is extinguished. When a malfunctioning missile is trapped out by squeezing the trigger while its SELECTED light is extinguished, the next tuned missile in the sequence is fired. If the missile continues to tune intermittently, it is automatically reset into the firing sequence when a fire signal is supplied to the last missile station in the normal firing sequence. It may then be fired by squeezing the trigger when the SELECTED light is illuminated. If the missile tunes properly (steady SELECTED light) after being trapped out, it may be immediately reset into the firing sequence by recycling the missile arm switch; it is automatically reset when a fire signal is supplied to the last missile station. On NEW F-4J with cockpit optimization, an intermittently malfunctioning missile can be manually stepped over and locked out by positioning the weapon select switch to SS while the SP light is illuminated. If the missile never tunes, it is automatically stepped over. On these F-4J, a stepped-over missile that tunes cannot be reset by cycling the missile arm switch. NEW NEW

(U) To check the status of forward fuselage missiles when a centerline store is aboard, the RIO must pull the missile fairing circuit breaker in F-4B or the radar missile fairing circuit breaker in F-4J thru 155843ai. When the circuit breaker is pulled, the TK light in the front cockpit extinguishes. The SELECTED/READY lights illuminate if the missiles are tuned. Replace the missile fairing circuit breaker (F-4B) or the radar missile fairing circuit breaker (F-4J). The SELECTED/READY lights extinguish and the TK light illuminates. On F-4N, F-4J 155844aj and up, and all other F-4B/J after removal of pseudo tuning, the forward fuselage missile status can be monitored with the missile fairing circuit breaker in, even though an external store is aboard the centerline station. NEW NEW

Note

In F-4B, the missile fairing circuit breaker is in zone G9, No. 1 circuit breaker panel. The radar missile fairing circuit breaker is in zone A8, No. 1 circuit breaker panel in F-4J 155529ag and up and others after AFC 388, and in zone D5, No. 1 circuit breaker panel in all other F-4J.

CAUTION

With the missile fairing circuit breaker pulled, the forward missiles can be launched with a centerline store aboard, resulting in severe aircraft damage.

(U) Co-channel CW Interference

(C) If two F-4J operating on the same CW frequency are locked on the same target, co-channel CW interference occurs and prevents AIM-7 guidance. If the non-shooting F-4J remains in search, a successful AIM-7E-2 missile launch is possible, but co-channel CW interference from the searching radar may cause early fuzing in an AIM-7D or AIM-7E missile.

AIM-7 MISSILE

(U) AIM-7 CAPABILITIES AND LIMITATIONS

(C) The AIM-7 was designed as a high altitude, all aspect, intercept missile and, as such, was not mechanized for employment in a high G, minimum range, or high clutter environment. In addition, the fire control system, which furnishes all pre-launch guidance information as well as minimum and maximum firing envelopes for the AIM-7, was optimized for a head-on attack at 40,000 feet altitude against non-maneuvering targets. The requirement for these design specifications is still valid; however, the F-4 in its multi-mission role as a fighter and interceptor must maintain the capability to employ its weapons in the ACM environment. When employing the AIM-7 missile system in a dogfight or low altitude environment, the following limitations should be recognized due to the basic interceptor design: A time delay of 4 seconds after lockon (1.5 seconds on F-4J with 1527 configuration radar sets) must be allowed prior to missile launch in order to provide accurate guidance information to the missile. Erroneous maximum and minimum launch ranges are generated by the fire control computer when employed against a maneuvering target. Guidance and fuzing capabilities are degraded in the presence of a high clutter or a look-down situation. The maneuvering capability and minimum launch range of the AIM-7E place severe limitations on its capability in the ACM environment. For more detailed analysis, refer to the Supplement NATOPS Flight Manual.

(U) DOGFIGHT COMPUTER

(C) The dogfight computer installed in dogfight optimized aircraft is designed to supply the aircrew with ACM in-range indications for AIM-7E-2 missiles on both a heads-up and heads-down display. AIM-9 launch zone solutions for the ACM environment are also provided but these computations should be ignored. The dogfight computer computes the ACM launch zones by utilizing the following inputs and assumptions:

a. Interceptor altitude inputs from sea level to 70,000 feet.
b. Target and interceptor speed
c. Range rate (V_c) inputs
d. Line of sight (LOS) rates
e. Range
f. The target is assumed to be maneuvering at a constant 4.5G and the interceptor is assumed to be attacking from the "hot side" with pipper on the target.

(C) The dogfight computer solutions are always displayed by the SHOOT light under the following conditions: (a) ready missile aboard or training/test override selected and (b) target in range. The computations are also displayed on the radar scopes when the missile interlock switch is in DOGFIGHT.

(C) Utilization of the training function is accomplished by placing the dogfight computer training/test switch to TNG/TEST. Either AIM-7 or AIM-9 missiles may be selected, even if they are not aboard, but the missile arm switch must be in SAFE. Normal procedures are followed in tuning the AIM-7 missiles, if aboard, and locking the radar on the target. The dogfight computer solves the ACM launch zone for the particular missile selected. When the computer determines that the selected missile can intercept the target, it supplies a signal to flash the SHOOT lights and the optical sight reticle. The radar must be locked on the target for approximately 1.5 seconds (F-4J) or 4 seconds (F-4B/N) before a SHOOT light can be obtained. All intercept procedures, except arming, up to trigger squeeze may be performed. If missiles are aboard, they cannot be launched since they are not armed.

Note

If the missile arm switch is placed to ARM, the dogfight computer training/test switch will unlatch and return to the NORM position.

(U) When the missile arm switch is placed to ARM, the missile firing circuits revert to normal operation and loaded missiles may be fired. Normal operation may be resumed without arming by manually placing the training/test switch to NORM.

(U) AIM-7 MISSILE ENVELOPES

(C) The missile envelopes presented in this manual should serve the aircrew as a base line from which to adjust as the tactical situation develops. The envelopes shown are drawn from guidance equations and show only that area from which, assuming speed-gate lockon, the missile has an 85 percent chance of guiding to within a 20-foot miss. The depicted envelopes do not address such problems as clutter, warhead lethality, etc. Non-maneuvering and maneuvering envelopes for representative altitudes and airspeeds are depicted.

(C) Figure 1-66 presents the difference between the non-maneuvering computed R_{max} and R_{min} as compared to the actual R_{max} and R_{min} performance capabilities of the missile. On F-4N, F-4J with 1527 configuration radar sets, and F-4B after AVC 860, the AIM-7E-2 functions as an AIM-7E when target range is greater than 5 nautical miles (F-4J) or 3 nautical miles (F-4B/N) if the missile interlock switch is in the IN or OUT position.

(C) Figure 1-67 presents AIM-7E-2 capabilities against a maneuvering target for three representative altitudes. The launch zones are shown for a constant 4.5G turning target. In the illustration, the target is turning to the left. Range is given in 0.5 or 1 nautical mile increments and TCA is given in 30° segments. The dogfight computer computations for

(C)
NEW the given conditions are also shown and depict the inherent errors in the computer. Depicted in the quadrant aft and to the inside of the target's turn is the ACM launch zone which is discussed later in this section. The AIM-7E maximum range capability is the same as the AIM-7E-2 in these conditions. AIM-7E minimum range data are not available for the depicted altitude/Mach conditions.

(U) AIM-7 PERFORMANCE

(U) AIM-7 LOW ALTITUDE CAPABILITY

(C) The major guidance and fuzing problems of the AIM-7 at low altitude are caused by sea/ground clutter. To the missile, the clutter appears to have a closing velocity equal to the ground speed of the missile. Also, if the intensity of the clutter is greater than that of the target return, the clutter will cause the missile automatic gain control circuits to reduce the missile receiver gain. This AGC action may sufficiently reduce the intensity of the target return to cause late or no speedgate lockon. Target fades can also be caused after speedgate lockon by AGC action which, in turn, can cause poor guidance and possible early fuzing. The effects of the clutter on the AGC are more pronounced when the missile is fired co-altitude or with a look-down. Also, the greater the firing range, the greater the possibility that target strength will be too low for the missile to maintain lock. Target fades or turbine modulation can cause early fuzing in the AIM-7E. The guard gate incorporated in the AIM-7E-2 reduces the possibility of early fuzing due to target fades or turbine modulation. The narrow sweep selection will prevent sea or ground main beam clutter from entering the speedgate sweep if the target ground speed vector toward or away from the missile is great enough to displace the clutter doppler frequency outside the narrow sweep frequency limits of ± 5 kHz (± 150 knots). The narrow sweep band is positioned to correspond to the closing velocity between the missile and the target. The clutter doppler corresponds to the missile ground speed. Since the clutter and the target have the same doppler frequency in a beam attack, either the head-on or stern attacks are recommended at low altitude. The highest probability of missile speedgate lockon occurs in the head-on attack. In this region, the doppler signal is separated completely from both main beam and side lobe clutter. In stern launches, although the target signal is separated from main beam clutter, it may still have to compete with side lobe clutter. Normally, the amplitude of the side lobe clutter is not sufficient to limit missile usefulness. Consideration of all factors leads to the following recommendations for employing AIM-7 missiles at low altitude:

a. The AIM-7 missile has the highest probability of success when launched in the forward quarter with a TCA greater than 140°, near minimum range, and from below the target but not lower than 500 feet.

b. Stern launches can be successfully accomplished with a high probability of success if: the target is above the interceptor; the pulse radar is being utilized; and the interceptor is as high as possible to minimize side lobe clutter effects on the missile speedgate.

c. Beam attacks should be avoided to prevent the target from being obscured by the clutter and to avoid the associated high angular rates.

ALTITUDE SWITCHING

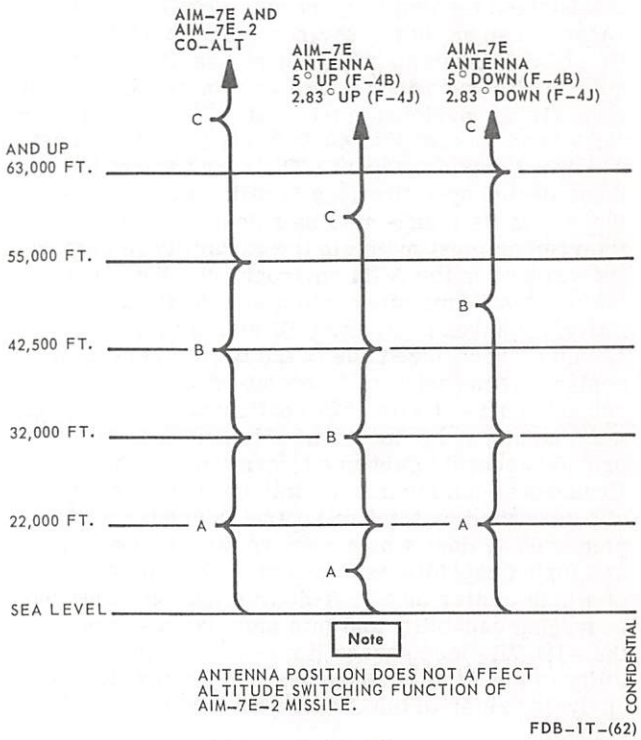


Figure 1-50 (C)

(U) AIM-7 LOOK-DOWN CAPABILITY

(C) Previous studies indicate that if the target is above 5000 feet and the fighter dive angle is less than 20°, full system AIM-7 launches will be effective most of the time. Two limiting factors are the ability to obtain AI radar lockon the possibility of premature fuzing in a high clutter environment. For a look-down shot, the AIM-7 has the best capability when fired head-on against a climbing target or tail-on against a diving target. Even under these conditions, a definite possibility of premature fuzing exists due to heavy clutter, jet engine modulations, and target fades. Degradation is greatest when V_C = TAS; i.e., when a beam aspect is presented.

Note

NEW Refer to Low Altitude Targets in part 6, this section, for AIM-7 employment against surface targets. NEW

(U) AIM-7 HIGH ALTITUDE CAPABILITY

(C) The AIM-7 has demonstrated an effective capability against targets up to 55,000 feet with the missile in band B autopilot constants (interceptor altitude at launch between 32,000 and 55,000 feet with NEW

(C)
NEW
less than a 5° - F-4B/N, or 2.83° - F-4J antenna look-up). Refer to Altitude Switching chart, figure 1-50. The AIM-7 will have marginal capability against targets above 50,000 feet when launched from a head-on attack in band C autopilot constants (interceptor above 55,000 feet at launch or above 42,500 feet with more than a 5° antenna look-up for the F-4B/N and 2.83° for the F-4J). The magnitude of the missile autopilot commands depends on, and increases proportionately with, target and interceptor altitude and closing velocity. The higher the altitude and closing velocity, the greater the magnitude of the missile wing commands. Since all targets present noisy signals to the missile, the guidance signals from the missile seeker head to the autopilot represent both noise and target signal inputs. When the missile is launched with band C autopilot gain settings, all incoming signals (both target signal and noise) are transmitted through the autopilot as full wing deflection commands. This situation causes erratic missile movement (porpoising) with the result that the missile seeker becomes unstable and cannot retain lockon. For this reason, AIM-7 launches should be made in band B autopilot constants. It is impractical for the aircrew to establish criteria for launching in different autopilot constants. Therefore, it is recommended that AIM-7 missiles be fired at co-altitude and mid-range when launched from a head-on attack. If the target is above 55,000 feet, the interceptor should maintain 50,000 feet altitude and launch at a maximum range. The AIM-7 missile has demonstrated capability against high altitude targets when launched from a stern attack. The AIM-7 has the capability of intercepting a target in this area when launched with a maximum opening rate of 300 knots. This is due to the missile sweep control circuits. AIM-7 launches with band C autopilot constants are also feasible in the stern area since closing velocities are much lower than in a head-on launch. The AIM-7 should not be launched from a beam attack due to the guidance problems involved and the vulnerability of the missile to chaff. The required antenna train angle in a beam attack may exceed the missile antenna gimbal limits (± 45°). This situation can occur even though the range and ASE interlocks are satisfied at the time of launch and is aggravated by a target speed advantage and an interceptor altitude disadvantage. The reason for this problem is the missile maneuvering required to intercept the target. After launch, the missile locks on the target and attempts (through guidance commands) to establish a collision course. A series of collision courses are constantly and instantly computed throughout the flight of the missile. Through normal deceleration after boost, the missile must generate more lead, and continued turning is required to maintain a collision course. These turning requirements will be increased when the missile is launched from an altitude disadvantage. If the missile antenna reaches the gimbal limits, it will become unstable and break lockon. There are instances where the computed missile antenna train angle required to place the target within the field of view of the missile at launch is beyond the gimbal limits. In these cases, missile lockon is precluded with resultant unguided flight to a wide miss.

(U) AIM-7 EMPLOYMENT TECHNIQUES AGAINST A MANEUVERING TARGET

(U) VISUAL ENGAGEMENT

(C) Once visual contact with the enemy has been attained, the following constraints must be considered for effective employment of the AIM-7 missile:

a. Forward quarter aspect - AIM-7E Missile:

In the forward quarter aspect, the small size of fighter airplanes makes the chances for a successful AIM-7E launch virtually nil. Maximum visual acuity ranges, the RIO's ability to acquire the target on radar, subsequent radar settling time, and missile speedgate positioning time requirements result in the range to the target being inside the 3 nautical mile minimum range before an AIM-7E launch can be initiated.

b. Forward quarter aspect - AIM-7E-2 Missile:

In the forward quarter aspect, the AIM-7E-2 missile has a real capability against a fighter size target in that the 2-nautical mile limited launch range can occasionally be satisfied. The constraints of radar settling time and subsequent missile speedgate positioning time can be satisfied if radar acquisition occurs at or beyond 3 nautical miles. On F-4J with 1527 configuration radar sets, the radar settling and speedgate positioning time has been reduced to approximately 1.5 seconds. This should provide a better chance for an AIM-7E-2 forward quarter shot. This should not be construed to mean that the enemy can best be defeated by meeting him head-on, but is applicable in the case where the enemy is aggressively maneuvering and the engagement is a "stalemate". Figure 1-51 depicts an acceptable aiming technique for a quick-shot, forward-quarter missile launch. In the forward hemisphere (180° to 120° TCA), positioning the bogey near the center of the front windscreen closely approximates the optimum lead required at launch.

NEW NEW

c. Beam aspect with the enemy turning away (belly up) - AIM-7E and AIM-7E-2:

When approaching a target that is turning away (belly up), R_{max} will be significantly reduced as a function of target G. In the instance of an AIM-7E missile fired against a 4.5G target turning away from the launching airplane, R_{max} collapses to within 4000 feet of R_{min}. The reduced minimum range capability of the AIM-7E-2 missile gives an added 3000 feet of firing envelope, but the dynamics of an ACM engagement make it extremely difficult to determine this narrow launch zone. The time that the launching airplane remains in this situation is of short duration. If the launching airplane delays firing and the enemy continues to turn, the target will rapidly present the more favorable 6 o'clock aspect.

BOGEY POSITIONING FOR AIM-7 SHOT

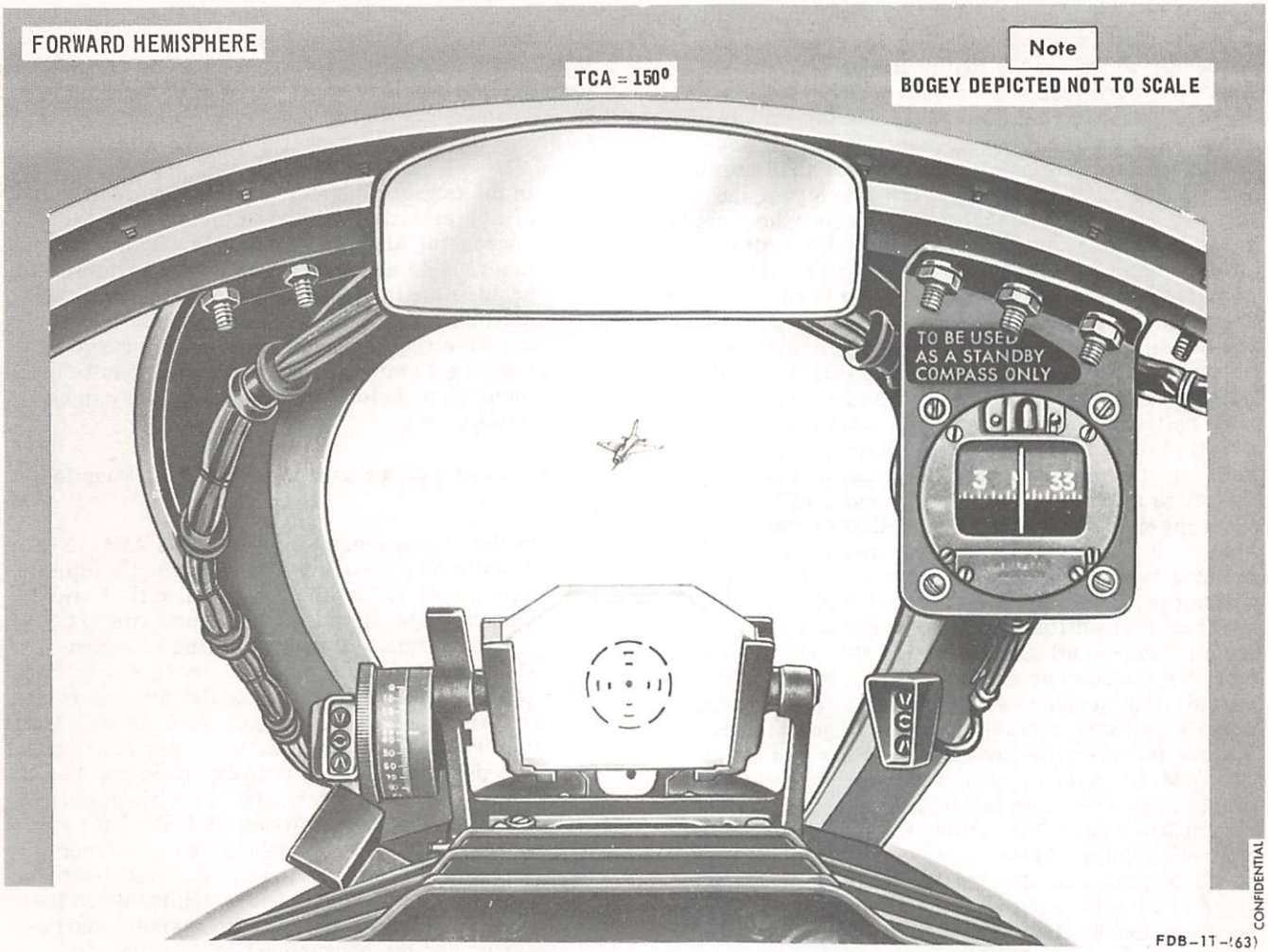


Figure 1-51 (C)

(C) Once the enemy has been visually sighted and engaged, an effective tactician will strive for a position in the rear quadrant inside his opponents direction of turn. This technique is as valid today as it was in Von Richthofen's era. The advent of air-to-air missiles merely enlarges the area (volume) within this quadrant from which a weapon can be launched to kill the enemy. In substance, what must be understood is that an all aspect, all weather missile gives a 360° kill capability to the F-4 when deployed in the interceptor environment, but in the ACM environment the first task at hand is the requirement to out perform the enemy and then destroy him. If the enemy has been out performed, the position that the F-4 has attained will be in the rear quadrant inside the enemy's turn. In the discussion that follows this quadrant will be termed the ACM launch zone.

(U) ACM LAUNCH ZONE

(C) The ACM launch zone is that space located within the aft quadrant inside the enemy's direction of turn. Its minimum range limit corresponds to the minimum launch range for the AIM-7E and AIM-7E-2 missiles. Its maximum range limit is determined by the AIM-7 missiles's ability to intercept any maneuvering target below 20,000 feet. Each of the AIM-7E-2 maneuvering envelopes located at the end of this part has the ACM launch zone shaded into the firing envelope. Investigation of any given set of parameters (i.e., target G, fighter and target speed, altitude, etc.) reveals, in that specific situation a considerable amount of the firing envelope is outside of the ACM launch zone. However, further investigation of firing envelopes resulting from different sets of parameters reveals that the area outside the ACM launch zone, still inside the firing envelope, is of considerably different size and shape. Therefore, the ACM launch zone was developed to provide the aircrew with workable guidelines for employing the AIM-7 in a maneuvering situation. The only constant utilized in determining the ACM launch zone is that the fighter and enemy have the same airspeed. It is also apparent that, if the F-4 is within the ACM launch zone when engaging a maneuvering enemy airplane below 20,000 feet, he is within the firing envelope.

NEW NEW (C) On aircraft equipped with the dogfight computer, the SHOOT light flashes when the fighter is within the computed AIM-7E-2 ACM launch zone (figure 1-67). On these aircraft, the SHOOT light indication should be utilized for AIM-7E-2 firings.

(U) AIM-7E ACM Launch Zone

(C) The AIM-7E missile differs from the AIM-7E-2 missile in the minimum range area only. The ACM launch zone for the AIM-7E missile is graphically depicted in figure 1-52. Minimum range is 1 nautical mile from 0° TCA to 40° TCA and 2 nautical miles from 40° TCA to 90° TCA. Maximum range is 2 nautical miles from 0° TCA to 40° TCA and 3 nautical miles from 40° TCA to 90° TCA.

Note

If a positive closing velocity (V_C) is present, the maximum range limit is 3 nautical miles from 0° TCA to 90° TCA.

AIM-7E ACM LAUNCH ZONE

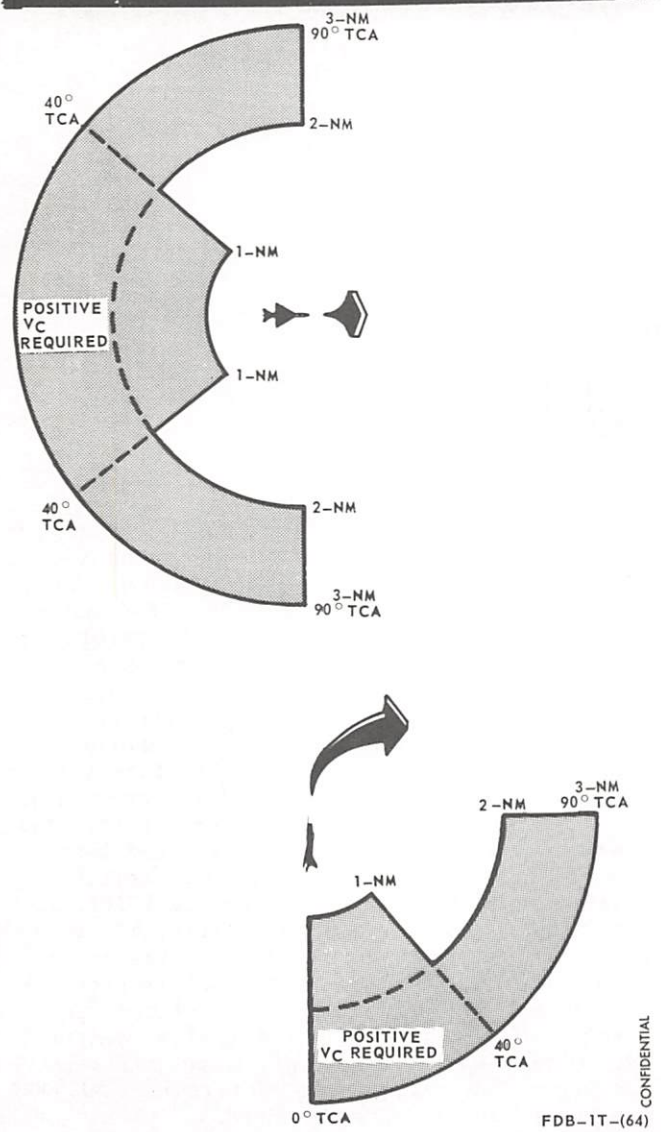


Figure 1-52 (C)

(C) Accurate determination of true TCA is difficult in an ACM environment. Along the 40° TCA line there exists ± 15° of overlap so that at the ranges from 1 to 3 nautical miles along this line, an AIM-7E missile can be successfully launched.

AIM-7E-2 ACM LAUNCH ZONE

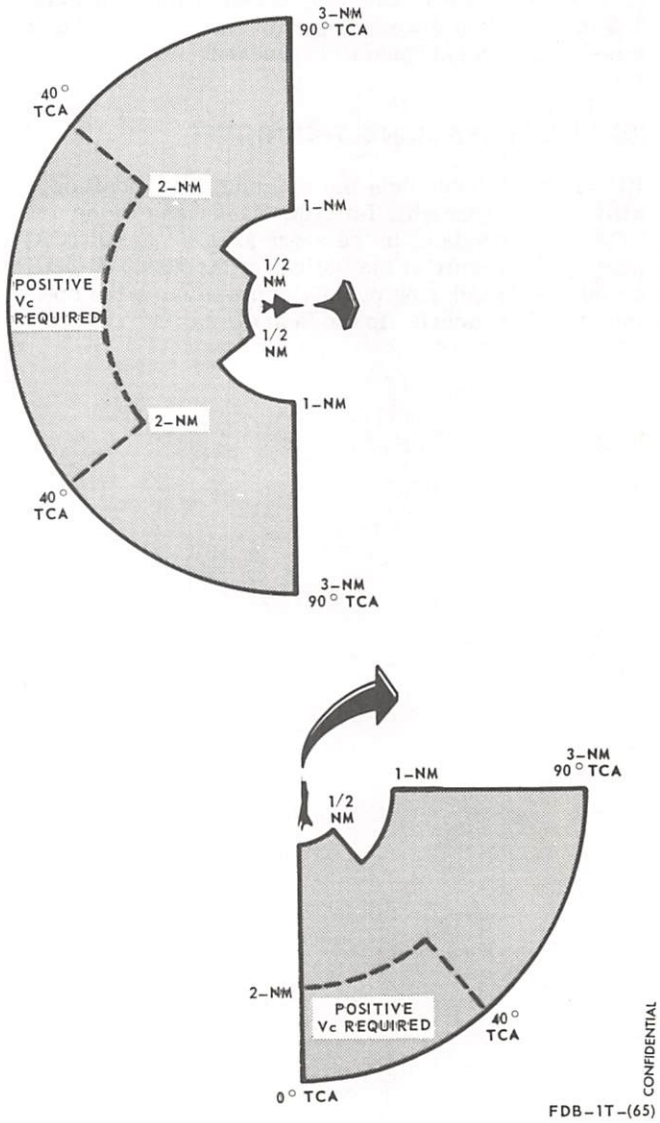


Figure 1-53 (C)

(U) AIM-7E-2 ACM Launch Zone

(C) The AIM-7E-2 missile reduces the minimum range limit of the ACM launch zone. The ACM launch zone for the AIM-7E-2 missile is graphically depicted in figure 1-53. Minimum range is 1/2 nautical mile from 0° TCA to 40° TCA and 1 nautical mile from 40° TCA to 90° TCA. The maximum range is the same as the AIM-7E missile; 2 nautical miles from 0° TCA to 40° TCA and 3 nautical miles from 40° TCA to 90° TCA.

Note

If a positive closing velocity (V_c) is present, the maximum range limit is 3 nautical miles from 0° TCA to 90° TCA.

(C) Accurate determination of true TCA is difficult in an ACM environment. Along the 40° TCA line, there exists ± 15° of overlap so that at the ranges of 1/2 to 3 nautical miles along this line, an AIM-7E-2 missile can be successfully launched.

(U) VISUAL TRACKING TECHNIQUES

(C) Figure 1-54 depicts the optimum nose position, utilizing the gunsight, for AIM-7 launches in the ACM launch zones. In the stern area (0° to 40° TCA), placing the enemy at the bottom of the 50/60 (F-4B/N) or 60 (F-4J) mil ring closely approximates the optimum lead at launch. In the beam area (40° TCA to 90° TCA), placing the enemy close to the bottom of the combining glass closely approximates the optimum lead at launch.

NEW

WARNING

If a friendly aircraft is within 7° of the target and has approximately the same closure rate, the AIM-7 may be unable to distinguish the correct target.

Note

If the situation will not allow pulling the optimum lead, firing with the enemy in the gunsight combining glass will satisfy the lead requirements for an AIM-7 launch in the ACM launch zone.

Figure 1-54 (C) (Sheet 1 of 2)

Figure 1-54 (C) (Sheet 2 of 2)

AIM-7 QUICK-SHOT REQUIREMENTS

AT TRIGGER SQUEEZE

WEAPONS SYSTEM

1. Missile power – ON
2. Missile/weapon select switch – RADAR/SP
3. Missile arm switch – ARM
   (minimum time – 1.8 seconds on F–4B/J before removal of pseudo tuning)
4. Radar tracking:
   a. Auto track – minimum tracking time 4 seconds (1.5 seconds on F–4J with 1527 configuration radar sets).
   b. Boresight – have target aspect switch set; keep target within 25 mils of pipper until missile impact.

AIMING TECHNIQUE

(Gunsight depressed to 35 mils)

1. Auto track:
   a. Non-maneuvering target – Aim dot in ASE circle.
   b. Maneuvering target –
      Head-on: bogey centered in front windscreen.
      Abeam: bogey tangent to the radome.
      Stern: bogey at bottom of 50/60 mil ring.
2. Boresight – keep target within 25 mils of pipper until missile impact.

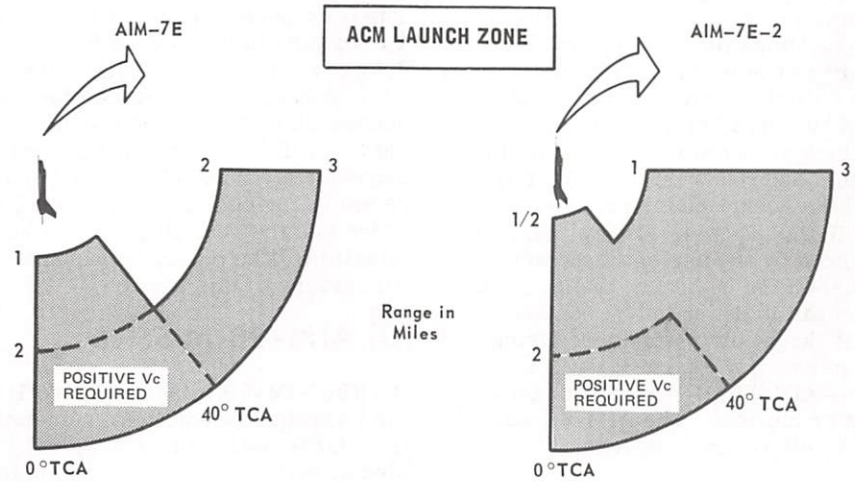
MISSILE RANGE ENVELOPE

1. MINIMUM RANGE:

	AIM–7E	AIM–7E–2
HEAD ON	3NM	2NM
ABEAM	2NM	1NM
ASTERN	1NM	½NM

2. ACM Launch zone – subsonic below 20,000 feet (V_f 1MN = V_t 1MN)

ACM LAUNCH ZONE



Notes

1. When possible, fire the AIM-7 in auto-track, narrow gate, interlocks out.
2. If all requirements are satisfied, ripple two missiles.

CONFIDENTIAL

FDB–1T–(67)

Figure 1-55 (C)

AIM-9 MISSILE

(U) AIM-9 MISSILE DESCRIPTION

(C) The operational theory and design principles of the AIM-9B, AIM-9D, and AIM-9G/H infrared missiles are quite similar although specific design changes in the AIM-9D and AIM-9G/H have resulted in greater tactical capabilities. The AIM-9G/H missile is identical to the AIM-9D except it has SEAM (Sidewinder Expanded Acquisition Mode) capability. The aircraft must be modified before the SEAM capability is functional. The following is a discussion of the areas in which all three missiles are identical. This is followed by a separate detailed discussion of the AIM-9B and AIM-9D/G/H. SEAM is discussed at the end of the AIM-9 missile discussion.

(C) The AIM-9B and AIM-9D/G/H missiles are supersonic, air-to-air, guided missiles that home on target infrared (IR) radiation. The missile flies a proportional-navigation intercept course and detonates its warhead upon colliding with, or passing near, the target. The missiles home on infrared energy radiated from the jet engine or, to a lesser extent, the reciprocating engines of the target. Homing is accomplished by a gyro-optical system designed to gather IR energy, process this energy into angular rate data, and produce tracking signals to maintain gyro-optical boresight on the target. The tracking signal is further processed and converted to missile airframe steering by a torque balance servo system. The torque balance servo produces missile turning rates approximately four times the gyro-optical tracking rate in degrees per second. This results in the missile flying a collision course to intercept. Propulsion is provided by a solid propellant high thrust rocket motor which accelerates the missile to supersonic speeds within seconds after launch. Four wings on the aft end of the rocket motor provide aerodynamic stability to the missile. Roll, pitch, and yaw damping are enhanced by the use of airstream driven gyros (rollerons) on the outboard trailing edge of each wing. The warhead is detonated by contact fuzing upon striking the target or by influence fuzing in the event of a near miss. If the missile fails to intercept the target, the AIM-9B/D/G warhead detonates after gas generator burnout. The AIM-9H warhead does not have this self-destruct feature.

(U) CAPTIVE FLIGHT

(C) During captive flight the gyro-optics are electrically caged along the missile axis which is aligned 2° below the fuselage reference line (35 mils on the fixed gunsight) unless utilizing SEAM. Electrical power is supplied by the aircraft through a power supply in the missile launcher. An audio tone heard by the pilot and the RIO indicates the presence of an IR source within the missile field of view. This IR source represents a potential target for the missile. The missile has no means of target identification and consequently, it homes on friendly as well as hostile aircraft. Also, audio tones are produced by sun reflections off clouds and some terrain features. Through practice, the aircrew can distinguish point sources of IR energy such as jet aircraft engines against an IR energy reflecting background. Identification of an IR point source against an IR background is made possible by placing an interference filter in the optical path to restrict the spectral range of energy that reaches the IR detector. This filter reduces the level of IR radiation noise caused by the presence of clouds and terrain within the missile field of view. When the target is centered in the missile field of view, little or no audio tone is obtained. This loss of audio tone or null can be mistakenly interpreted as a loss of target.

(U) LAUNCH PHASE

(C) The launch phase is commenced when the pilot squeezes the trigger. Upon squeezing the trigger the gyro-optics are uncaged and automatically track the target. Also, at this time the gas generator is ignited. The gas generator applies pneumatic power to the torque balance servo system and drives the turbo-alternator which supplies electrical power to the guidance and control section. When the turbo-alternator output achieves a specified voltage and frequency, a firing relay in the aircraft launcher power supply closes which ignites the rocket motor and activates the thermal battery in the fuze. The turbo-alternator has been replaced by a thermal battery in the AIM-9H. The time from trigger squeeze to missile launch is a maximum of 0.8 second for the AIM-9B/D/G and 0.4 second for the AIM-9H. After launch the servo guidance section is disabled for an additional 0.5 second which allows the missile to clear the launching aircraft before missile maneuvering. The firing sequence for the AIM-9B, AIM-9D/G and AIM-9H is shown in figure 1-58. The specific design characteristics and the resulting tactical capabilities for each missile will be discussed separately in subsequent paragraphs of this section.

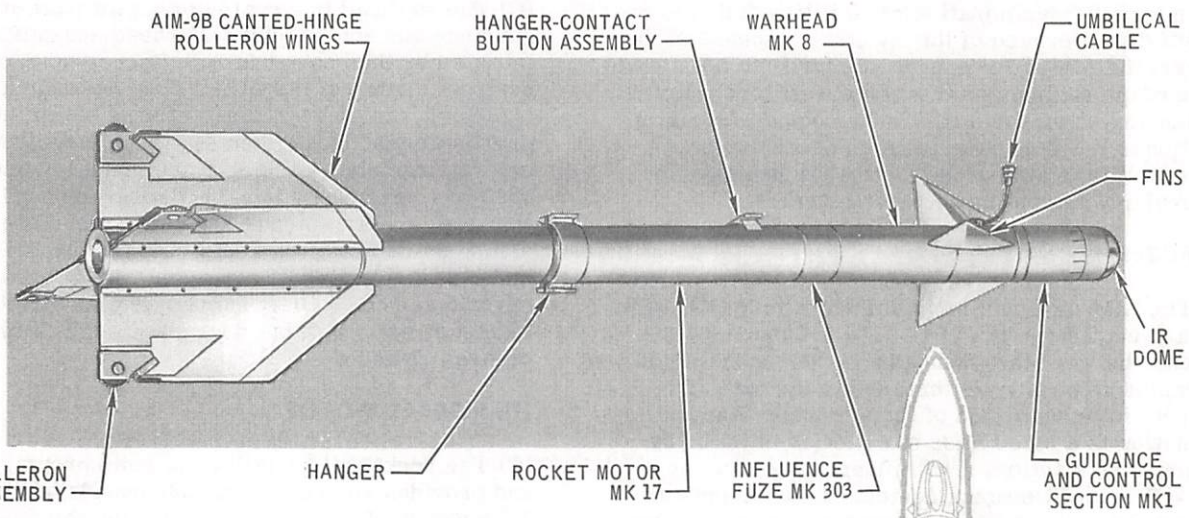
(U) AIM-9B MISSILE

(C) The AIM-9B missile (figure 1-56) is composed of the following assemblies: guidance and control section, fuzes, warhead, motor, and wings. The assembled missile is 5 inches in diameter and 112 inches long.

(U) GUIDANCE AND CONTROL SECTION

(C) The forward end of the guidance and control group (GCG) is housed behind a clear pyrex glass dome. This hemispherical dome provides a window for the gyro-optics IR tracker. Significant specifics of the GCG are: field of view of 4°, gimbal angle limits of ± 25°, gyro tracking rate of 8° - 11° per second, and a guidance time of 21 seconds. These parameters affect the performance capabilities of the AIM-9B and therefore, affect the tactics used with them. Although adequate detection ranges can

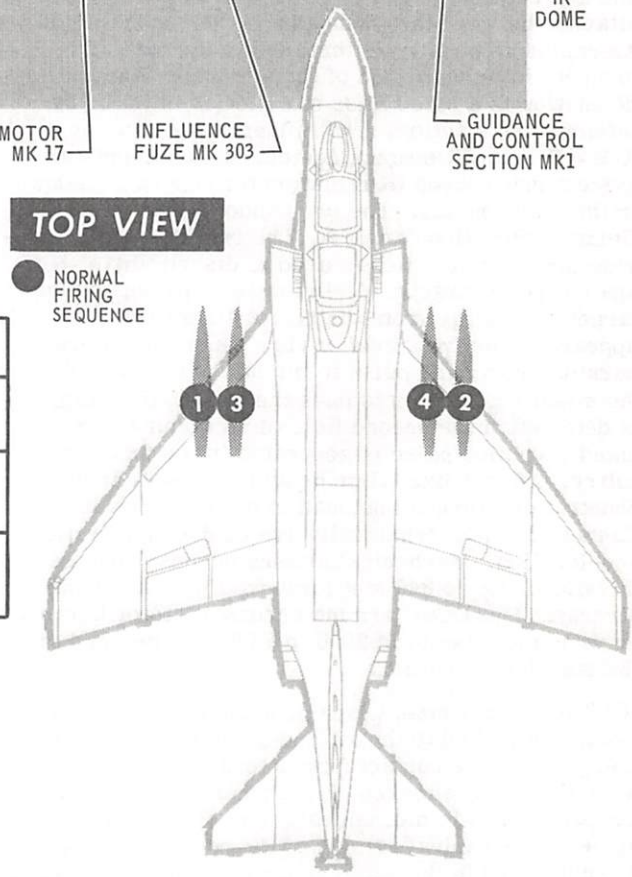
AIM-9B MISSILE



RULE OF THUMB

1. MINIMUM RANGE	NON-MANEUVERING TARGET	CONTACT FUZE – 1000 FT. INFLUENCE FUZE – 3000 FT.
	MANEUVERING TARGET	LAUNCH WITHIN 25° ANGLE OFF WITH 2G OR LESS AT LAUNCH
2. MAXIMUM RANGE	1 NM AT SEA LEVEL. INCREASES 0.5 NM FOR EACH 10,000 FEET OF ALTITUDE.	
3. HEART OF ENVELOPE	0.75 NM AT LESS THAN 20° ANGLE OFF.	

TOP VIEW



WEIGHT	REFER TO APPENDIX A
LENGTH	9 FEET, 4 INCHES
DIAMETER	5 INCHES
THRUST	3820 LBS. FOR 2.2 SEC.
SEEKER FIELD OF VIEW	4°
GIMBAL LIMITS	± 25°
ELECTRICAL POWER UNIT	21 SEC. DURATION
FUZING	CONTACT AND INFLUENCE
WARHEAD EFFECTIVE RADIUS	30 FEET (CONTROLLED FRAGMENTATION)
VELOCITY	1.7 MACH (ABOVE LAUNCH SPEED)
MINIMUM RANGE	3000 FEET CO-SPEED TAIL-ON ATTACK
MAX. GYRO TRACKING RATE (NOMINAL).	8°-11°/SEC
TURN CAPABILITY	12G (SEA LEVEL)

CONFIDENTIAL

FDB-1T-(69)

Figure 1-56 (C)

(C)
be obtained against a blue sky background, clouds and other highly reflective background such as water, snow, and desert degrade target discrimination. The 4° field of view represents a compromise between target discrimination capabilities and seeker sensitivity. Because of the spectral response of the seeker, the AIM-9B responds primarily to hot metal parts of the engine, and therefore is severely limited at high angles off the tail. These considerations, in addition to the limited missile maneuvering capability, limit the size of the tactical launch envelope, particularly against maneuvering targets.

(U) FUZES

(C) The AIM-9B contains an influence fuze (MK 303) and a contact fuze (MK 304). The influence fuze is attached between the warhead and the rocket motor. An explosive booster is threaded to the fuze and projects into the aft end of the warhead. Warhead detonation in a close miss situation is initiated by influence fuze action. The influence fuze for the AIM-9B is an IR sensing device. It has an optical system that senses IR radiation through two windows in the fuze housing. The two windows have different fields of view (look angles). The two look angles provide information which is used to discriminate against false targets. As the missile passes by the target, IR energy from the target aircraft engine appears in the first field of view generating a preparatory command pulse in the fuze circuitry. As the missile continues to pass the target, IR energy is detected in the second field of view and a command execution pulse is generated in the fuze circuitry. After a fixed time delay to allow optimum penetration, warhead detonation occurs. The influence fuze is mechanically armed during missile acceleration. Mechanical arming occurs when the missile is 480 to 840 feet forward of the launching aircraft. Electrical arming occurs at motor burnout or when the missile is 2000 to 2500 feet forward of the launching aircraft.

(C) The contact fuze, which protrudes into the warhead, is attached to the aft end of guidance and control group. The contact fuze detonates the warhead when the missile makes direct contact with the target provided it is mechanically and electrically armed. Mechanical arming of the contact fuze is accomplished in the same manner as the influence fuze; i.e., when the missile has accelerated 480 to 840 feet forward of the launching aircraft. Electrical arming of the contact fuze occurs at umbilical shear. This provides an AIM-9B minimum firing range of approximately 1000 feet for contact fuzing. The fuze is actuated by piezoelectric crystals mounted in the fin rocker arms of the guidance and control group. When the missile strikes the target the shock to the rocker arms causes the crystals to generate a voltage. This voltage triggers the contact fuze, resulting in instantaneous detonation of the warhead. Because the influence fuze does not become fully armed until motor burnout, which occurs at 2000 to 2500 feet, the AIM-9B missile fired at a range greater than 1000 feet but less than 2000 to 2500 feet will have contact fuze capability only. If the missile does not approach near enough to the target for fuze action, a self-destruct sequence is initiated when loss of internal power occurs.

(U) WARHEAD

(C) The warhead is mounted to the aft part of the guidance and control unit. Warhead detonation is initiated by the contact fuze, influence fuze, or self-destruct circuit of the GCG. Upon detonation of the explosive, the steel warhead case is blown into approximately 1300 fragments. These fragments accelerate rapidly, reaching a maximum velocity of 6000 feet per second in a 360° pattern around the warhead, and will pierce 3/8-inch steel plate at a distance of 30 feet. In addition to the lateral dispersion, the fragments are accelerated forward with missile velocity. Blast damage is also effective to 10 feet at sea level, but degrades rapidly with increased altitude.

(U) ROCKET MOTOR

(C) The rocket motor utilizes a solid propellant fuel and provides an average of 3820 pounds of thrust for 2.2 seconds of burning time, boosting the missile to 1.7 Mach above aircraft launch speed. Power to the motor igniter is transferred through the aft contact button on the forward hanger. A nonpropulsive attachment (NPA) attached to the nozzle of an assembled missile neutralizes thrust if the motor is inadvertently ignited.

WARNING

The NPA must be removed just before loading the missile on the aircraft. An AIM-9B missile fired on an aircraft with a NPA installed can result in destruction of the aircraft.

(U) WINGS

(C) Four wings with rolleron assemblies are mounted on the aft end of the motor to give the missile lift and stability. In captive flight the rolleron assemblies are mechanically caged. Rolleron wheels, which are mounted on the tips of the rolleron assembly, are rotated at all times by the airstream. After the missile is launched, the rollerons are uncaged. During missile flight, gyroscopic action of the spinning rolleron wheels produce a force on the wings which counteracts oscillations in pitch, yaw, and roll. The AIM-9B can be equipped with wings that have straight hinge line or canted hinge line rollerons. Straight hinge line rollerons are effective only to counteract roll and normally, they are used only for training. Wings with canted hinge line rollerons are preferred and may require the installation of caging clips to aid the caging pin when carried on certain aircraft stations.

Note

To prevent an unbalanced aerodynamic response, a combination of straight and canted hinge line rollerons should not be used on a missile.

(U) AIM-9D/G/H MISSILE

(C) The AIM-9D/G/H missile (figure 1-57) is a more effective and versatile missile than the AIM-9B. It is designed for use against high or low speed aircraft flying at altitudes between sea level and 80,000 feet. The AIM-9D/G/H consists of the following sections: a guidance and control group (GCG), a fuze consisting of the target detecting device (TDD) and safe arming device (S-A), a warhead, a rocket motor, and four wing assemblies.

(U) GUIDANCE AND CONTROL GROUP

(C) The guidance and control group gyro-optics section is enclosed within the missile nose section just aft of the translucent IR dome. Streamlining of the missile nose reduces drag and is made possible by miniaturization of the gyro-optics assembly. A magnesium fluoride dome material is used on the AIM-9D/G/H missile. This dome withstands extreme thermal environment and prevents saturation or decoying of the missile from the target. The gyro seeker unit has a 2.5° field of view and ± 40° gimbal limits. The maximum tracking rate of the AIM-9D/G is 12° per second at boresight and degrades somewhat as the seeker look angle increases. The solid state AIM-9H has a higher torque seeker unit which provides a 20° per second tracking rate throughout the ± 40° gimbal limits. Additionally, because of the replacement of the turbo-alternator with a thermal battery, the AIM-9H has approximately 250 inch-pounds more torque available to drive the canards. Seeker sensitivity and target discrimination has been improved in the AIM-9D/G/H over the AIM-9B missile by the addition of a gaseous nitrogen cooling system which cools the detector to -196°C. When nitrogen is not available, clean, dry, compressed air may be utilized as a suitable substitute. Gaseous cooling provides the additional benefit of improved target to background discrimination by shifting the response of the detector away from solar radiation temperature and toward engine tailpipe temperature. The relatively small field of view plus improved optical filtering also contribute to improved detection and target to background discrimination. AIM-9D/G/H guidance time is 60 seconds.

(U) FUZES

(C) The fuze contains the target detecting device (TDD) and the safe-arm (S-A) device. The TDD is mechanically attached and electrically connected to the (GCG). The S-A device, which protrudes into the warhead, is mechanically and electrically joined to the TDD. The primary function of the TDD is to sense the target and cause warhead detonation at the point of maximum kill probability. When the missile passes within a predetermined distance of the target, the TDD sends a firing signal to the explosive train in the S-A device, causing initiation of the warhead booster and detonation of the warhead. If the missile contacts the target a signal from a piezoelectric crystal in the fin rocker arm initiates the explosive train in the S-A device. If the AIM-9D/G missile passes out of range of the target, a self-destruct feature in the GCG detonates the warhead through the firing circuit of the S-A device after gas generator grain burnout. The TDD operates from a thermal battery and is independent of the missile power supply. Firing current is applied to the thermal battery squib 0.1 second before missile launch.

(C) The S-A device primarily performs dual functions. One function is that of preventing detonation of the warhead during handling and until the missile to launching aircraft separation distance is 480 to 840 feet. The other function is to arm the warhead so that detonation takes place after the missile has traveled the specified distance. The S-A device performs these functions by keeping the units of the explosive train, which it contains, in a misaligned condition until the missile has reached a safe distance from the aircraft, and then bringing them into alignment. The sequence of events that controls the action of the S-A device is as follows:

a. An electrical signal received from the launching aircraft actuates the solenoid launch-latch, unlocking the mechanism.
b. The S-A senses missile acceleration during the boost phase of flight and, if sufficient acceleration has been maintained, advances to commit-to-arm position (480 to 840 feet from the launching aircraft). If the missile motor malfunctions and burnout occurs before the missile attains the minimum missile-to-aircraft separation distance of 480 feet, the S-A device does not reach the commit-to-arm position, but returns to the SAFE position.
c. If missile acceleration is normal, the S-A device continues past the commit-to-arm position, and arming is completed.
d. On target intercept, an electrical signal from the TDD firing circuit initiates the explosive train leading to the warhead booster, which detonates the warhead.

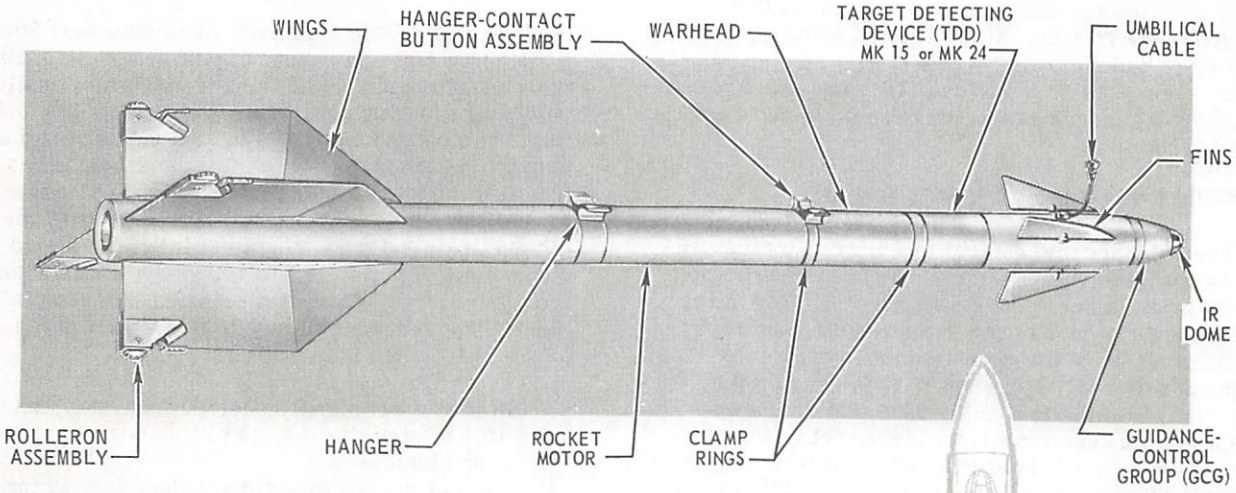
(U) WARHEAD

(C) The warhead is a continuous rod constructed of a bundle of 3/8-inch square rods 10 inches long and welded together at alternate ends. Upon detonation the rod bundle expands at right angles to the missile at a rate of 4000 feet per second to a maximum radius of 17 feet. Forward missile velocity also is imparted to the continuous rod which causes it to move forward as well as laterally in a cone shape, with the apex of the cone at the point of detonation. This steel ring can knife through skin and skeletal members of aircraft structure. Because the continuous rod does not depend on blast effect for damage, its destructiveness is not degraded with an increase in altitude.

(U) ROCKET MOTOR

(C) A single stage solid propellant motor, which provides an average of 2880 pounds of thrust for 5.0 seconds, boosts the AIM-9D/G/H to 2.5 Mach above the speed of the launching aircraft. Approximately 0.1 second after the motor firing current is applied, motor ignition occurs. After motor burnout the missile coasts toward the target for the remaining 55 seconds of guidance time or until it decelerates to speeds below which guided flight can be maintained.

AIM-9D/G/H MISSILE



RULE OF THUMB

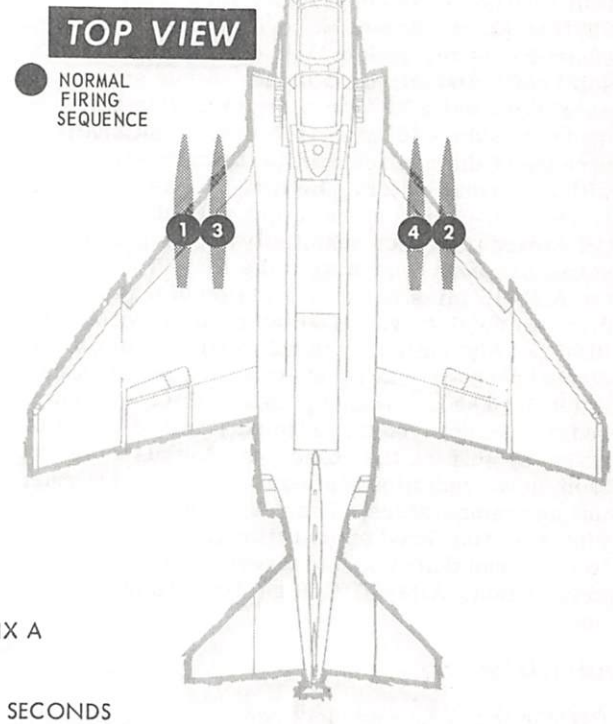
1. MINIMUM RANGE:
   1000 FEET PLUS 1000 FEET FOR EACH 10° ANGLE OFF THE TARGET TAIL.

   NOTE

   - SEAM – FIRING WITH LEAD ENHANCES AIM-9G/H PERFORMANCE.
   - RECOMMEND MINIMUM RANGE LAUNCH WITH 40° OR LESS ANGLE OFF AT FIGHTER SIZE TARGETS BECAUSE OF FUZING CONSIDERATIONS.

2. MAXIMUM RANGE:
   1 TO 2 NM AT SEA LEVEL PLUS 1 NM FOR EACH 10,000 FEET OF ALTITUDE.

3. HEART OF ENVELOPE:
   6000–8000 FEET RANGE AT LESS THAN 40° ANGLE OFF THE TARGET TAIL.



WEIGHT	REFER TO APPENDIX A
LENGTH	9 FEET, 5 INCHES
DIAMETER	5 INCHES
THRUST	2880 LBS. FOR 5.0 SECONDS
SEEKER FIELD OF VIEW	2.5° (APPROXIMATELY 44 MILS)
GIMBAL LIMITS	± 40°
ELECTRICAL POWER UNIT	60 SEC DURATION
FUZING	CONTACT AND INFLUENCE
WARHEAD EFFECTIVE RADIUS	17 FEET (CONTINUOUS ROD)
VELOCITY	2.5 MACH (ABOVE LAUNCH SPEED)
MINIMUM RANGE	1000 FEET CO-SPEED TAIL-ON ATTACK
COOL DOWN TIME	60 SECONDS
MAX. GYRO TRACKING (NOMINAL)	12°/SEC (AIM-9D/G) 20°/SEC (AIM-9H)
TURN CAPABILITY	18G (SEA LEVEL)

CONFIDENTIAL

FDB-1T-(70)

Figure 1-57 (C)

(U) WINGS

(C) The four wing assemblies of the AIM-9D/G/H missile function in the same manner as those of the AIM-9B missile except that the AIM-9D/G/H wings are larger. Also, wings with the straight hinge rollerons are not installed on the AIM-9D/G/H missile.

(U) AIM-9 MISSILE PERFORMANCE

(U) AIM-9B MISSILE PERFORMANCE AGAINST NON-MANEUVERING TARGETS

(C) The AIM-9B minimum range against co-speed, non-maneuvering targets is 1000 feet for contact fuzing and 3000 feet for contact and influence fuzing. Minimum range is increased (decreased) 300 feet for every 0.1 Mach of positive (negative) overtake.

(C) The AIM-9B maximum range against co-speed non-maneuvering targets is approximately 6000 feet below 10,000 feet MSL and increases 3000 feet for each 10,000 feet of altitude (e.g., 9000 feet when launched at 20,000 feet MSL). Maximum range also increases (decreases) by 1000 feet for each 50 knots of positive (negative) overtake. The angular boundaries of the AIM-9B non-maneuvering launch zone are determined by the lambda limits of the missile (26°) and is 30° off the tail of the target.

(U) AIM-9B MISSILE PERFORMANCE AGAINST MANEUVERING TARGETS

(C) The AIM-9B has not demonstrated a capability against a high-G maneuvering target. It does have a limited capability against a target pulling up to 3G, if launched at an angle off of less than 25° and at a launch G of 2G or less. The capability of the AIM-9B against a maneuvering target is limited by the lambda limit (look angle) in the guidance and control group and by the aerodynamic capability of the missile. When the AIM-9B is employed against a maneuvering target, ensure it is launched as close to 0° angle off as possible and at mid range (4000-5000 feet).

(U) AIM-9D/G/H MISSILE PERFORMANCE AGAINST NON-MANEUVERING TARGETS

(C) The AIM-9D/G/H is highly effective against non-maneuvering targets. The most severe limitation to the missile is the fact that it is generally a rear hemisphere weapon. To acquire a target, an IR source must be within the missile field of view. When SEAM is not employed, the pilot must position the aircraft with the boresight axis pointing at the IR source since the AIM-9D/G/H gyro-optics are caged along the missile axis until the missile is fired. The missile has no means of target identification and will home on any IR source. Therefore, when possible, approach the target from below and attempt to keep the target within 25 mils of the missile boresight before firing. There is no requirement that the target be tracked for a specified time either before or after firing as long as the tone is present. If within the firing envelope, a snapshot can be as effective as a long tracking shot. There is approximately an 0.8-second delay before the AIM-9D/G missile leaves the launcher rail. The AIM-9H leaves the rail in 0.4 second. If possible, the target should be tracked until the missile has launched and appears to be guiding. It should be noted that it is possible to receive an audio signal from a target while outside maximum firing range of the missile. Maximum detection range is a function of target type, power setting, angle off, and background. Detection range with a target boresighted against a blue sky background is almost double that of one boresighted against clouds or the ground. As a general rule, detection range against an afterburning target is double that of a non-afterburning target.

(C) Minimum range for the AIM-9D/G/H at 0° angle off, against a co-speed, non-maneuvering target is 1000 feet as determined by fuze arming time. As angle off increases, minimum range increases rapidly because of the difficulty in accertaining the precise launch conditions during a rapid changing situation, the following rule-of-thumb is recommended:

MINIMUM LAUNCH RANGE EQUALS 1000 FEET PLUS AN ADDITIONAL 1000 FEET FOR EACH 10° ANGLE OFF UP TO 60° TCA

(C) Maximum range for the AIM-9D/G/H is limited by guidance time available to the missile but it is more often determined by missile velocity; i.e., when missile velocity decreases below approximately 750 feet per second and stable flight can no longer be maintained. This limitation results in a maximum range of 1 to 2 miles at sea level, increasing 1 mile for each 10,000 feet of altitude (figure 1-59). Because of the wider look angle of the AIM-9D/G/H seeker (40°) and improvements to the guidance and control section, the AIM-9D/G/H is capable of intercepting targets up to 60° TCA. Representative AIM-9D/G/H non-maneuvering envelopes are shown in figure 1-68 at the end of this part.

MAXIMUM LAUNCH RANGE IS 1 to 2 MILES AT SEA LEVEL AND INCREASES BY 1 NAUTICAL MILE FOR EACH 10,000 FEET OF ALTITUDE.

Note

The preceding rules are designed to ensure successful guidance if the target should break into the missile after launch. This is not to preclude the aircrew from firing at a less agile target from any aspect, provided the criteria of having a good IR tone is met and launch occurs within the specified missile envelope.

AIM-9 MISSILE TIME SEQUENCE

TIME (SEC)	AIM-9B	AIM-9D/G	AIM-9H
	TRACKING TARGET	TRACKING TARGET	TRACKING TARGET
–0.8	1. TRIGGER SQUEEZE 2. GAS GENERATOR IGNITION 3. GYRO OPTICS UNCAGE	1. TRIGGER SQUEEZE 2. GAS GENERATOR IGNITION 3. GYRO OPTICS UNCAGE 4. UNLOCK ARMING MECHANISM – MK 13 S&A DEVICE	
–0.4			1. TRIGGER SQUEEZE 2. GAS GENERATOR IGNITION 3. GYRO OPTICS UNCAGE 4. UNLOCK ARMING MECHANISM – MK 13 S&A DEVICE
–0.2	TURBO–ALTERNATOR UP TO VOLTAGE AND FREQUENCY	TURBO–ALTERNATOR UP TO VOLTAGE AND FREQUENCY	THERMAL BATTERY UP TO VOLTAGE
–0.15	LAUNCHER FIRING RELAY CLOSES	LAUNCHER FIRING RELAY CLOSES	LAUNCHER FIRING RELAY CLOSES
–0.1	1. ROCKET MOTOR IGNITION 2. MK 303 INFLUENCE BATTERY ACTIVATED	1. ROCKET MOTOR IGNITION 2. TDD BATTERY ACTIVATED	1. ROCKET MOTOR IGNITION 2. TDD BATTERY ACTIVATED
0	1. MISSILE LAUNCH (UMBILICAL SHEAR) 2. MK 304 FUZE FIRING CIRCUIT PROTECTOR (ELECTRICAL GROUND) REMOVED 3. ROLLERONS UNCAGE	1. MISSILE LAUNCH (UMBILICAL SHEAR) 2. ROLLERONS UNCAGE	1. MISSILE LAUNCH (UMBILICAL SHEAR) 2. ROLLERONS UNCAGE
0.5	STEERING CAPABILITIES INITIATE (COMMAND SIGNALS APPLIED TO SERVO)	STEERING CAPABILITIES INITIATE (COMMAND SIGNALS APPLIED TO SERVO)	STEERING CAPABILITIES INITIATE (COMMAND SIGNALS APPLIED TO SERVO)
1.2	MK 304 FUZE MECHANICALLY ARMED		
1.8		MK 13 S&A FULLY ARMED	MK 13 S&A FULLY ARMED
2.2	MOTOR BURNOUT		
2.3	MK 303 FUZE FULLY ARMED		
5.0		MOTOR BURNOUT	MOTOR BURNOUT
21.0	END OF GUIDANCE AND GAS GENERATOR BURNOUT		
24.0	SELF DESTRUCT		
60.0		END OF GUIDANCE AND GAS GENERATOR BURNOUT	END OF GUIDANCE AND THERMAL BATTERY POWER EXHAUSTED
63.0		SELF DESTRUCT	

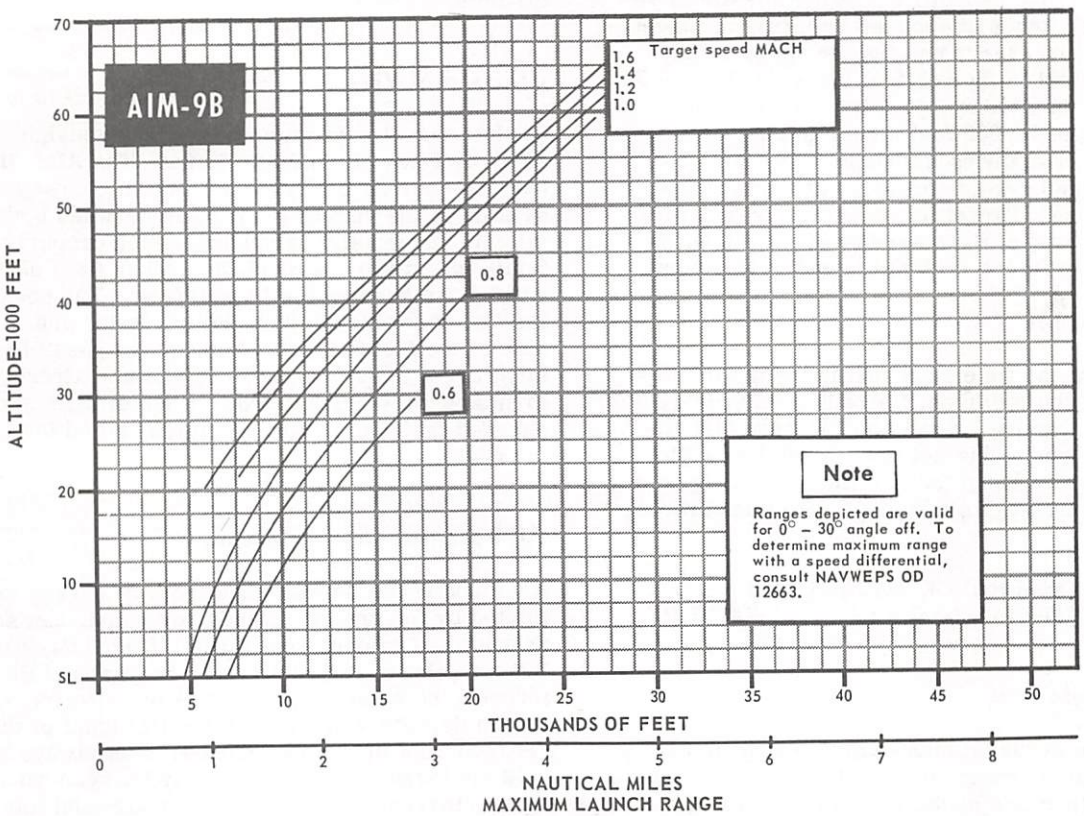
CONFIDENTIAL

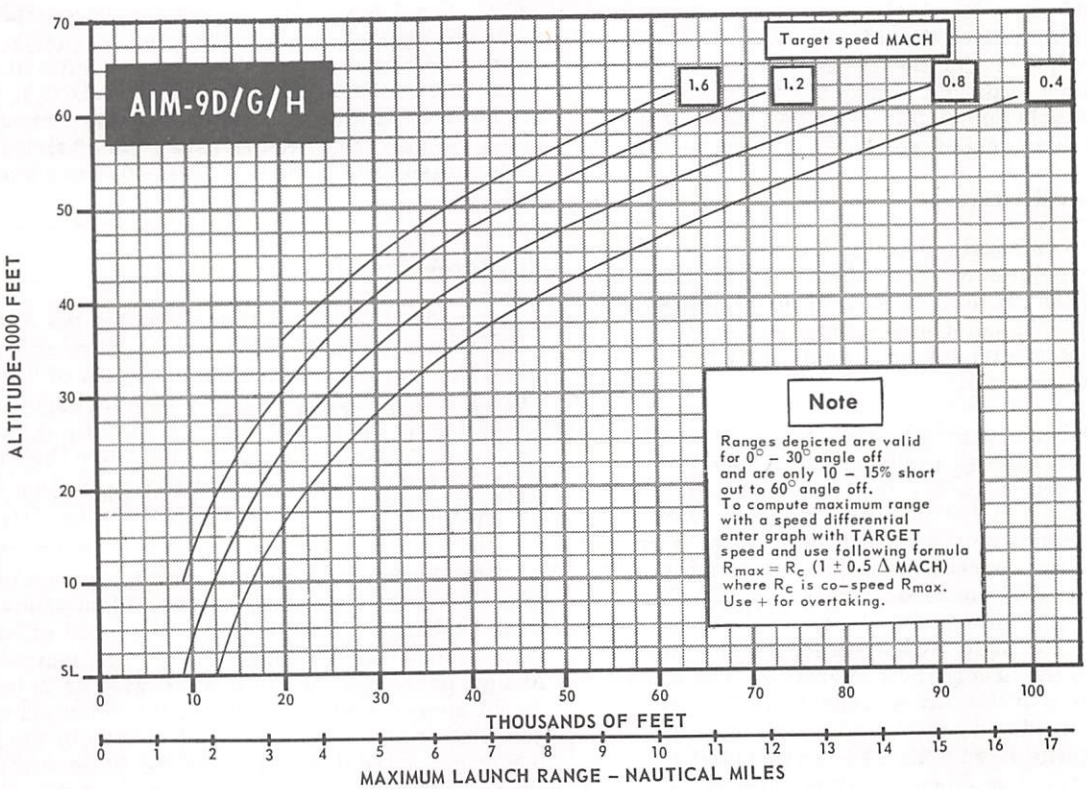
FDB–1T–(68)

Figure 1-58 (C)

MAXIMUM LAUNCH RANGE

CO-SPEED, CO-ALTITUDE, TAIL-ON ATTACK





CONFIDENTIAL

FDB–1T–(216)

Figure 1-59 (C)

(U) AIM-9D/G/H MISSILE PERFORMANCE AGAINST MANEUVERING TARGETS

(C) To effectively employ the AIM-9D/G/H missile in the ACM environment, a knowledge of the maximum and minimum range capabilities of the missile is required. Launch zones are varied by altitude, target speed, target maneuver, and fighter speed. They are asymmetrical in the vertical plane due to gravity and variations in air density. Pitch-up shots at a target more than 10,000 feet higher in altitude will require nose-up attitudes in excess of 30° for co-speed targets and greater nose-up attitudes if the target is opening. Target maneuvering greatly distorts the geometry of the non-maneuvering launch zones. Refer to figure 1-68 at the end of this part.

(U) Rmin Envelope

(C) Angle off at the time of launch is the major factor in defining the minimum range in a maneuvering environment. Closing velocity and altitude also affect minimum range, but not to the extent of angle off. The minimum range rule of thumb used against non-maneuvering targets also applies to maneuvering targets.

MINIMUM LAUNCH RANGE EQUALS 1000 FEET PLUS AN ADDITIONAL 1000 FEET FOR EACH 10° ANGLE OFF

(U) Rmax Envelope

(C) The degree of target maneuver has a profound effect on maximum range shots. It is possible under some maximum range shots for the target to turn more than 180° prior to missile intercept. This situation essentially places the missile in a forward quarter intercept. Under these conditions, a successful intercept is doubtful since the missile envelope boundary is completely dependent on the target maintaining a constant speed, G, and IR source.

(U) Target Load Factor

(C) The target maneuvers listed in the envelopes refer to the horizontal component of the total airplane load factor. Thus, reference to a 5G turn implies, in addition to the 5G horizontal component, a 1G vertical component giving a total load factor of slightly greater than 5G.

(C) Target G has a significant effect on the AIM-9D/G/H envelope because of its direct relationship to angle off (referred to as TCA during missile flight). As the angle off the target increases, an increased turning performance on the part of the missile is required to make the corrections necessary to intercept the target. This condition can only be satisfied by allowing greater time and distance (increasing minimum range as angle off increases) for the missile to perform the necessary maneuvers. The envelopes assume that the target turns at the instant the missile is fired and continues its turn until intercept. A missile fired with lead is presented a simplified intercept problem as the missile is launched on a partial collision course and the initial tracking rate is reduced

(U) AIM-9D/G/H EMPLOYMENT AGAINST MANEUVERING TARGETS

(C) Effective employment of the AIM-9D/G/H in an ACM environment should consider the following constraints:

(U) Field of View

(C) In a visual environment the fixed gunsight is used as a reference for missile firing. The AIM-9D/G/H has a seeker field of view 2.5° which corresponds to 44 mils in the gunsight. In 1G flight when both the missile and gunsight are boresighted properly, the 5 mil null in the center of the seeker field of view will be centered on the fixed pipper. The seeker field of view extends 22 mils up, down, and to either side of the fixed pipper. A check for possible boresight error should be made on another aircraft prior to entering the combat area. Each missile should be checked individually and deviations noted for use during flight.

(U) Background Interference

(C) Background interference from IR energy as reflected by the ground, clouds, or moon, can severely degrade the guidance capability of the AIM-9D/G/H. When a pilot is confronted with background IR interference, he must maneuver to a position from which he can definitely distinguish the IR signal of the target from that of the background. It is always best to hold the target against a blue sky background when firing, thereby eliminating all background interference. The AIM-9D/G/H cannot be successfully launched against a target obscured by clouds. Clouds diffuse IR radiation and the target signal will not reach the seeker. Additionally AIM-9D/G/H should not be fired at a target heading into the sun, as solar radiation may decoy the missile. Delay firing until the missile is pointed at least 30° away from the sun.

(U) Target Tracking

(C) In order to obtain a firing tone for the AIM-9D/G/H without utilizing SEAM, the pilot must boresight the target. Maintaining boresight of a maneuvering target rapidly leads to the attacking aircraft flying inside the prescribed angle off/R_{min} limitations. This implies learning to acquire the tone and firing in the minimum amount of time before angle off or R_{min} limits are exceeded.

(C) The IR signature of any aircraft as seen by the missile varies with aircraft type, flight attitude, and power settings. In general, the IR source of any aircraft is decreased as angle off or TCA increases. At high power settings in basic engine or in burner, the IR source may be sufficient for detection and guidance from all aspects. But in view of the general tendency toward degradation of the IR source as angle off increases, it is recommended the missile launch be accomplished as close to 0° angle off as possible with 60° as an acceptable maximum.

(U) Fuzing

(C) There are two TDD available for the AIM-9 missile: the MK 24 IR unit and the MK 15 RF unit. The latter TDD has proven superior against maneuvering targets and is recommended for use in the ACM environment. The MK 24 (IR) TDD is maintained for use against bomber type targets due to its tendency to detonate late at the medium and high TCA created by a maneuvering target. If the MK 24 TDD must be used in an ACM environment, missile launch should be attempted as close to 0° angle off as possible. The MK 15 TDD has been modified to operate in a quick reacting two pulse mode of operation. Even this fuze encounters problems with late detonation in a high TCA intercept. The details of this fuze are secret but, in general, when using the RF fuze, launch conditions which result in a high angle off should be avoided because of reduced kill probabilities. While present AIM-9D/G/H launch conditions against a maneuvering target are limited to 60° TCA for guidance considerations, launch opportunities against hard turning fighter sized targets are further restricted to 40° TCA due to the MK 15 TDD inability to properly detect the target during the resultant high velocity, high TCA intercept. Launch conditions in excess of the preceding limitation may well result in failure of the warhead to detonate or detonation so late that the target receives little or no damage.

(U) Effect of Pursuit Tracking

(C) There is no launch G restriction for the AIM-9D/G/H. While high G forces on the launch aircraft will probably lead to a high angle off, this, in itself, should not be interpreted as a launch restriction. The missile may be fired, if envelope and tone requirements have been satisfied, regardless of G on the firing aircraft. In order to obtain a firing tone when not utilizing SEAM, the target must be boresighted. Maintaining boresight on a maneuvering target rapidly leads to the attacking aircraft flying inside the prescribed angle off/R_{min} limitations. This implies learning to acquire the tone and firing in a minimum amount of time before angle off or R_{min} limits are exceeded, as illustrated in figure 1-60.

(U) One Mile Method

(C) R_{min}, R_{max}, and angle off limitations have defined the basic launch envelope. The problem then lies in determining when you are inside it. Statistics have shown that most missiles which have been launched outside the missile envelope have been launched at ranges closer than R_{min}. Studies have shown that our most difficult problem is accurate range determination. In controlled tests, visual estimations of range by qualified pilots where shown to be consistently in error by 50 to 200 percent.

(C) Angle off is also difficult to determine accurately. Experimentation has shown that estimates to within 15° of actual angle off are the best that can be expected of even the most qualified pilots. For purposes of visual estimation, it is recommended that every effort to be made to fire at what is estimated to be within 40° angle off. This will ensure that firing will probably occur within the 60° recommended limit for angle off. The 1-mile range, therefore, extends to 40° either side of the targets tail and is shown as the cross-hatched area in figure 1-61.

(C) The 1-mile method is an attempt to give the pilot a specific range for which to strive, thus placing him in the "heart of the envelope". This range is sufficiently inside the ACM, low-altitude, launch envelope to the degree that if a reasonable error is made in estimating range or angle off, you will probably still be within the envelope at the time of launch.

(C) If you think in terms of a single range you can translate this into a single sight picture. For example, a MIG-21 is 4.5 mils at 6000 feet (figure 1-54). By studying this sight picture until it is instantly recognized, a pilot can then more readily access deviation from it. This permits almost instinctive reaction to a maneuvering situation.

(C) The 1-mile method does not deny the use of the entire envelope, rather it allows the pilot to instinctively maneuver to a range of 1 mile knowing that other ranges can be acceptable under certain conditions. Therefore, while the pilot is considering whether or not his present position is adequate for a shot, he is automatically improving his position by striving for 1 mile.

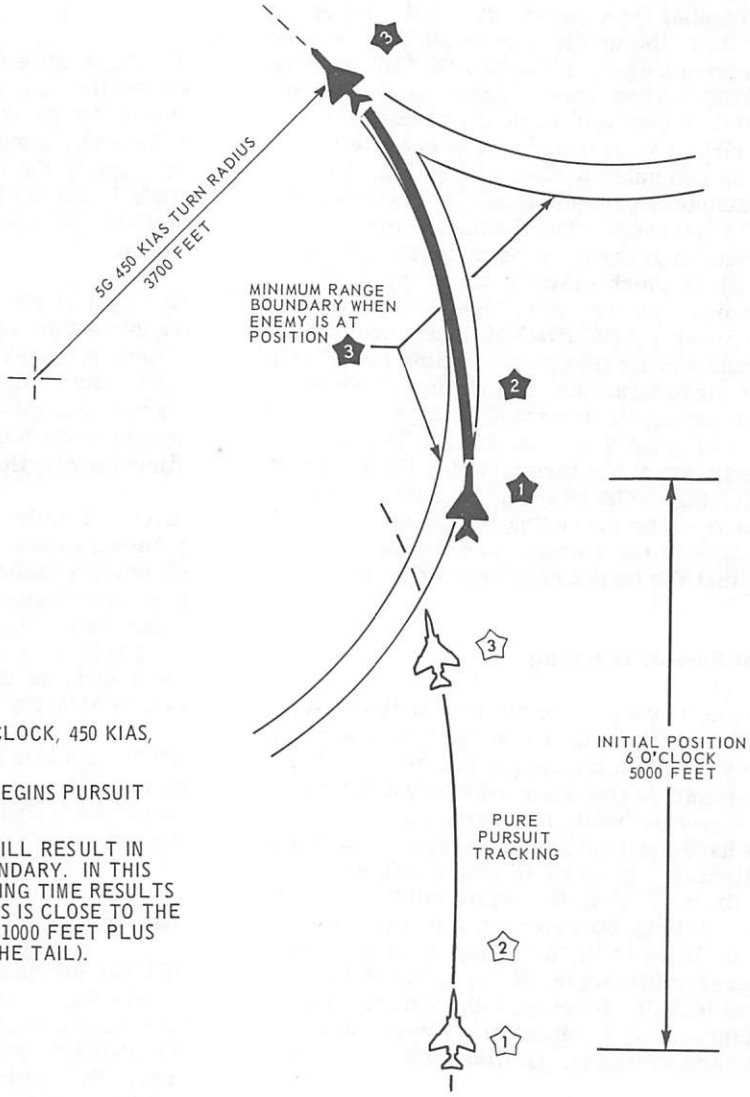
(C) To use this method successfully, you must immediately be able to recognize the sight picture of threat aircraft at 1 mile. The 2-mil fixed pipper is the only reference for visual range estimation.

(U) Firing

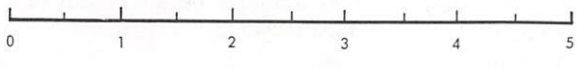
(C) The missile can be fired with the target anywhere within the 44-mil field of view of the seeker head. As the trigger is pressed, the seeker unit is uncaged and immediately precesses to center the target in the null. This will result in a reduction or loss of tone, not because the seeker is no longer seeing the target, but because it is tracking in the null. Do not fire without tone, thinking the target is in the null. If it is in the null, this would result in good guidance, however, the lack of tone you attribute to the null may actually be the result of a missile or aircraft malfunction.

(C) The benficial effects of firing with as much lead as possible within the missile field of view are negligible and the risk of losing the target off the field of view during high-G combat maneuvering is great. Since the seeker boresights the target as soon as the trigger is pressed, the only advantage of using lead within the field of view is that of giving the missile a maximum of 1.25° (22 mils) of aerodynamic lead. This does not aid missile performance significantly, and when weighed against the possibility of losing the target while tracking, is viewed as a poor procedure.

PURE PURSUIT TRACKING EFFECT ON FIRING AIM-9



1. F–4 5000 FEET BEHIND ENEMY AT 6 O'CLOCK, 450 KIAS, AND CO-SPEED.
2. ENEMY ENTERS 5G LEVEL TURN; F–4 BEGINS PURSUIT TRACKING TO MAINTAIN TONE.
3. EXCESSIVE PURE PURSUIT TRACKING WILL RESULT IN OVERFLYING THE MINIMUM RANGE BOUNDARY. IN THIS EXAMPLE, 4 SECONDS ELAPSED TRACKING TIME RESULTS IN A 36°ANGLE OFF AT 4700 FEET. THIS IS CLOSE TO THE AIM–9D MINIMUM RANGE OF 4600 FEET (1000 FEET PLUS 1000 FEET FOR EACH 10° ANGLE OFF THE TAIL).



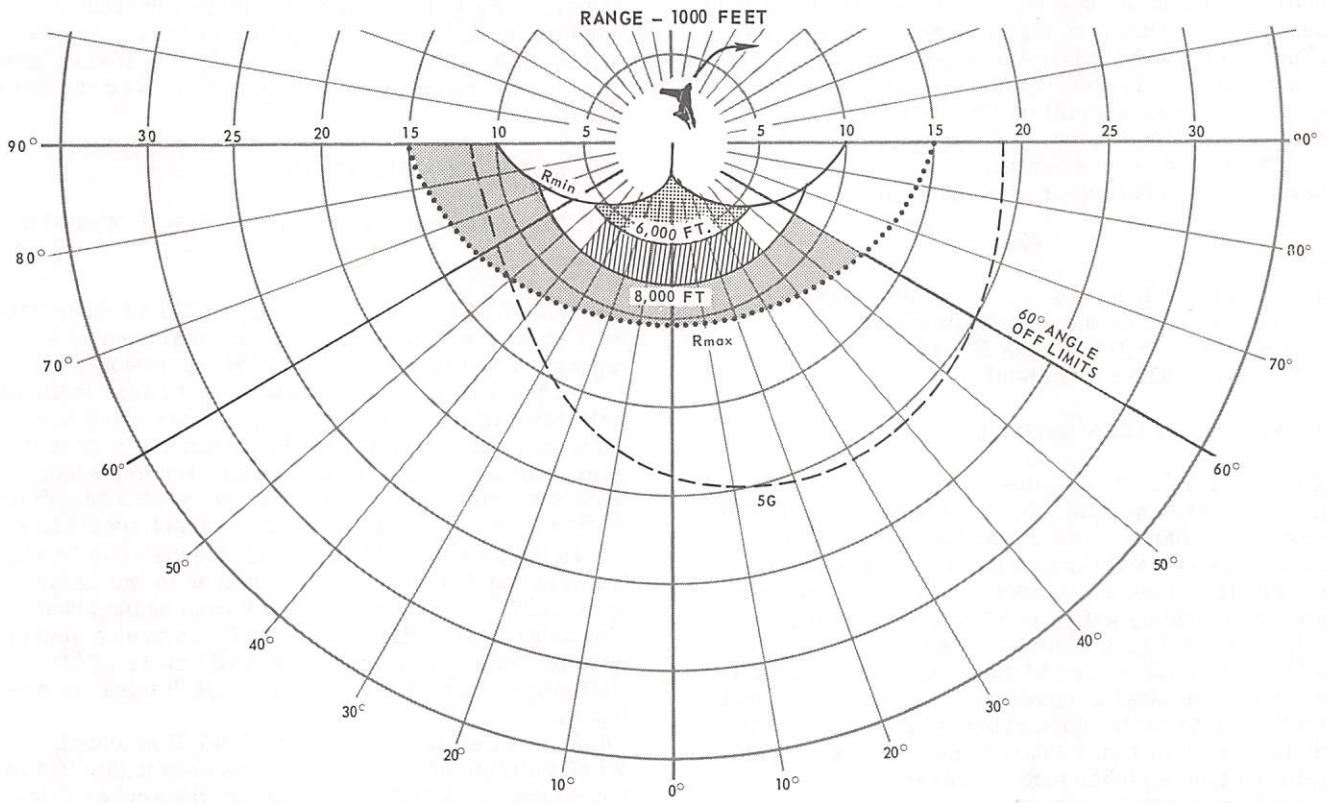
SCALE – 1000 FEET

CONFIDENTIAL

FDB–IT–(234)

Figure 1-60 (C)

ONE MILE METHOD ENVELOPE



Notes

- 1-mile method illustrated by cross-hatched area.
- Full use of envelope allowed by recognizing and utilizing deviations from 1-mile method.

CONFIDENTIAL

FDB-1T-(217)

Figure 1-61 (C)

(U) Ripple Firing

NEW (C) Firing more than one missile at a time is not recommended because of the probability of the second missile guiding on the first. After launching the first missile the pilot should attempt to maintain a position from which a second missile could be launched if required; shoot, look, shoot.

(U) SIDEWINGER EXPANDED ACQUISITION MODE (SEAM)

(U) GENERAL

NEW (C) SEAM (AIM-9G/H) is a modification of the AIM-9D Sidewinder heat-seeking missile which permits uncaging the missile seeker head and locking on and tracking an IR target while the missile is still mounted on the aircraft launcher. It incorporates the capability of slaving the missile seeker head to the radar antenna after radar lockon in order that an off-boresight missile lockon can be achieved. The missile may also be locked on an IR target, independent of radar lock, at or near boresight. Once locked on, the missile will track the target to the gimbal limits of the seeker head.

NEW (C) The SEAM missile seeker head nutates in a nominal 4.6° circular pattern at a rate of one rotation per second. This nutation, termed scan, allows a wider field of view for AIM-9G/H lockon. Targets within this scan pattern with a IR source that generates proper detection voltages for either the AIM-9G or AIM-9H can be locked on. After lockon the seeker head attempts to position the IR source at dead center. This position normally causes a null or no aural tone condition which is impossible to differentiate aurally from a no target condition. To NEW NEW NEW

(C) enable a distinctive lockon aural tone, a dither or small seeker head drive signal is introduced after lockon at a rate of four times per second. This dither signal produces a distinctive chirp tone modulated at the same rate (4 Hz). This tone also allows aural differentiation of a point source target (airplane tailpipe) and a large IR source (sun or bright cloud). However, the IR source must be discrete enough to produce a null or this chirp tone becomes a warble or steady tone. This state is called detector saturation and occurs against high level IR returns (target in afterburner or at close ranges).

Note

AIM-9D/G/H missiles may be identified during preflight by the modification number on the GCG: MOD 1 - AIM-9D, MOD 2 - AIM-9G, and MOD 3 - AIM-9H.

(U) AIM-9G/H SEAM MISSILE

(C) The AIM-9G SEAM missile has the same outward appearance as the AIM-9D, but has been modified to make it compatible with the SEAM system. The basic GCG (Guidance and Control Group) includes only minor modifications which provide a constant reference point to provide positive positioning of the seeker head dependent on the missile station selected. The AIM-9H missile is a solid state version of the AIM-9G and is identical in appearance but has a few modifications internally which provide the AIM-9H with a slight minimum range improvement. These components include a higher torque seeker (capable of 20° per second tracking rate at all gimbal angles vice 8°-12° per second for AIM-9G), replacement of the turbo-alternator with a thermal battery (AIM-9H launches in 0.4 second vice 0.8 second for AIM-9D/G), and an increase of 250 inch-pounds of torque (1, 350 inch-pounds vice 1, 100 inch-pounds) for driving the canards.

(C) The SEAM missile uses the LAU-7/A missile launcher with compressed nitrogen coolant, as does the standard AIM-9D. The airplane fuselage-to-launcher cable and the power supply-to-missile umbilical have also been modified to permit SEAM control functions. If the SEAM system fails, the missile may be fired as a standard AIM-9D provided VTAS power is OFF or the mode switch is in VTAS and the TAE (target acquisition enable) switch is not pressed.

Note

- On aircraft without the SEAM capability, the AIM-9G/H can be fired as an AIM-9D.
- Do not fire the missile in the SEAM scan mode without seeker lockon.

(U) SEAM ADVANTAGES

(C) The principle advantages realized by the AIM-9G/H are: the ability to maneuver with an IR target off-boresight while retaining a missile tone; the capability of firing the missile with the target positioned other than at boresight; and the inherent increase in probability of kill when the missile is fired with lead angle. SEAM provides the capability to fire with lag; however, R_{min} increases by 4000 to 6000 feet depending on lag angle and angle off at trigger squeeze, and the initial maneuver required by the missile after launch may cause the seeker head to exceed the gimbal limits.

(U) MODES OF OPERATION

(C) The SEAM missile has four modes of operation:

a. With VTAS power OFF or in the VTAS mode with no TAE action, the missile can be employed as a normal boresight missile (AIM-9D operation).

b. In the SEAM/PLM mode without a radar lock, the selected AIM-9G/H seeker head nutates about boresight in a nominal 4.6° circular pattern at a rate of approximately 1 Hz. This nutation, termed scan, allows a wider field of view for seeker lockon. Full-Action on the TAE switch enables target acquisition.

c. In the SEAM/PLM mode with the radar in track, the selected AIM-9G/H seeker slaves to the radar antenna (22° from boresight limit) and scans about that axis. Full-Action on the TAE commands seeker lockon. Note that in the SEAM/PLM mode, TAE Half-Action has no function with AIM-9 missiles selected.

d. With VTAS mode and an AIM-9G/H selected, VTAS pointing of the seeker is possible within 22° of boresight. TAE Half-Action points the seeker coincident with the pilot's helmet line-of-sight and TAE Full-Action commands acquisition.

(C) In addition to the aural lock indication (chirp tone), three lights and a radar scope display depict a lockon condition. A light labeled SEAM, below the SHOOT light alongside the left angle-of-attack indexer, illuminates. Another SEAM lock light is on the AIM-9 status panel beneath the left glare shield (F-4J). The lower left helmet sight discrete light indicates an AIM-9G/H lockon. A SEAM lock display consisting of a fixed reference circle and a missile seeker head position dot is displayed on both scopes.

(U) SEAM GROUND CHECKS

(U) When the aircraft is on internal generator power, the missile coolant switch should be placed in OVRD 2 minutes before commencing tone and slaving checks. Standard tone checks with an IR tester should be conducted. Next, with the VTAS power switch in TEST and an AIM-9G/H station selected, the selected missile seeker head should automatically slave 15° right at zero elevation. A missile head position display on both radar scopes will verify this test. Pressing the TAE to Full-Action should drive the missile head back to boresight.

Note

If there is a high IR source present, i.e., sunlight reflecting off a parking ramp, etc., the seeker head can lock on and wander away from boresight. If this occurs disregard the check and retest airborne. Failure of the head to slave 15° right or return to boresight could indicate a failure within the SEAM program. After all checks are completed, return the coolant switch to NORM.

(U) SEAM AIRBORNE PROCEDURES

(U) Once airborne each AIM-9 is checked for missile boresight error. This check compares the missile null tone position on an IR target with the 35 mil pipper (ADL) on the gunsight. Any error noted will not be compensated for by the SEAM system and probably stems from misalignment of that particular LAU-7/A launcher or a gunsight error. This check must be conducted in the VTAS mode with no TAE action.

(C) To acquire IR targets at boresight, the pilot must select the SEAM/PLM mode, any AIM-9G/H loaded station, and visually align the target with boresight. Initially the selected AIM-9G/H seeker scans about boresight unless the radar is locked on, in which case the missile seeker scans about the radar antenna axis. In either case a scan tone will be heard at a frequency of about 1 Hz. The SEAM mode logic diagram is depicted in figure 1-62.

(C) Pressing the TAE to Full-Action commands seeker lockon. If an IR source generates the proper detection voltage for either the AIM-9G or AIM-9H missile, the seeker will lock on. Both SEAM lockon lights illuminate and a seeker head position dot is displayed on both radar scopes. If the helmet sight is being utilized, the lower left discrete light also illuminates. An aural indication of seeker lockon is provided by a distinct tone change from the 1 Hz scan tone to a 4 Hz chirp tone. AIM-9G/H lockon can be rejected by stepping to another station, selecting AIM-7 or guns, or pressing the TAE to Full-Action and releasing.

(C) In the VTAS mode, SEAM acquisitions are essentially the same except that Half-Action on the TAE slaves the seeker to the helmet sight and starts the scan. Full-Action again commands lockon. In the VTAS mode, the upper left discrete light on the helmet sight also displays target/helmet sight coincidence while the seeker is locked on or being pointed.

(U) AIM-9 LAUNCH ENVELOPE DISCUSSION

(U) The term launch envelope is meant to define the volume of space from which a missile can be launched with high expectation of destroying its target. Many factors contribute to the determination of the launch envelope and these should be clearly understood if the performance capability of the weapon is to be interpreted properly.

(U) For AIM-9 missiles, the infrared source, kinematic capabilities of the missile airframe, and lethal [illegible] characteristics of the fuze-warhead combination against the particular target must be evaluated. These are usually considered separately and published envelopes may not include all three considerations. It is, of course, necessary that the missile receive adequate infrared radiation from the target in order to generate guidance commands. The amount of energy received depends upon the target characteristics (number of engines, power setting, and geometry of design) as well as the effects of background and meteorological interference (sun reflections from sand, water, clouds, etc.). Adequacy of the IR signal level is best determined by the aircrew during the attack and published launch envelopes do not, therefore, usually include this factor explicitly.

Note

To preclude loss of the IR signal from a hard maneuvering target, attempt to limit missile launch to a maximum of 60° angle off the target tail.

(C) Assuming the missile intercepts its target, the success of the mission depends on the effectiveness of the fuze-warhead combination. This in turn depends on the geometry of the intercept and the structural design of the target as well as the particular fuzing technique and warhead damage mechanism employed. For example, there exists launch conditions well within the infrared and kinematic envelope boundaries for which even a contact hit may not result in significant damage to the target. Because of the dependence on structural design of the target and the statistical nature of the miss distance, published launch envelopes do not usually include the factor of terminal effectiveness.

(C) Fuzing response of the MK 15 MOD III TDD against hard maneuvering, fighter size targets is generally most difficult during those intercepts where missile/target TCA approaches 90° and closing velocities are high. For the best fuze-warhead effectiveness, the aircrew should attempt to further limit missile launch to less than 40° angle off the target tail. This is not meant to imply that the missile is ineffective at higher launch angles but is intended to point out where the missile has maximum potential for destroying the target. The envelopes shown in figure 1-68 show that a missile can be launched from within the region defined by the minimum and maximum range boundaries, provided adequate IR signal is available, and it can be expected to guide to within close proximity of the target. As previously stated, the amount of damage to the target depends on additional factors.

(U) The maximum range boundary for small angles off the target tail is usually determined by propulsion and aerodynamic drag forces on the missile. The rocket motor provides a speed advantage for the missile and it continues to close on the target until aerodynamic drag slows it below the speed of the target. This portion of the boundary is strongly influenced by the variation in air density with altitude. Target and launch speeds are also factors.

SEAM OPERATION

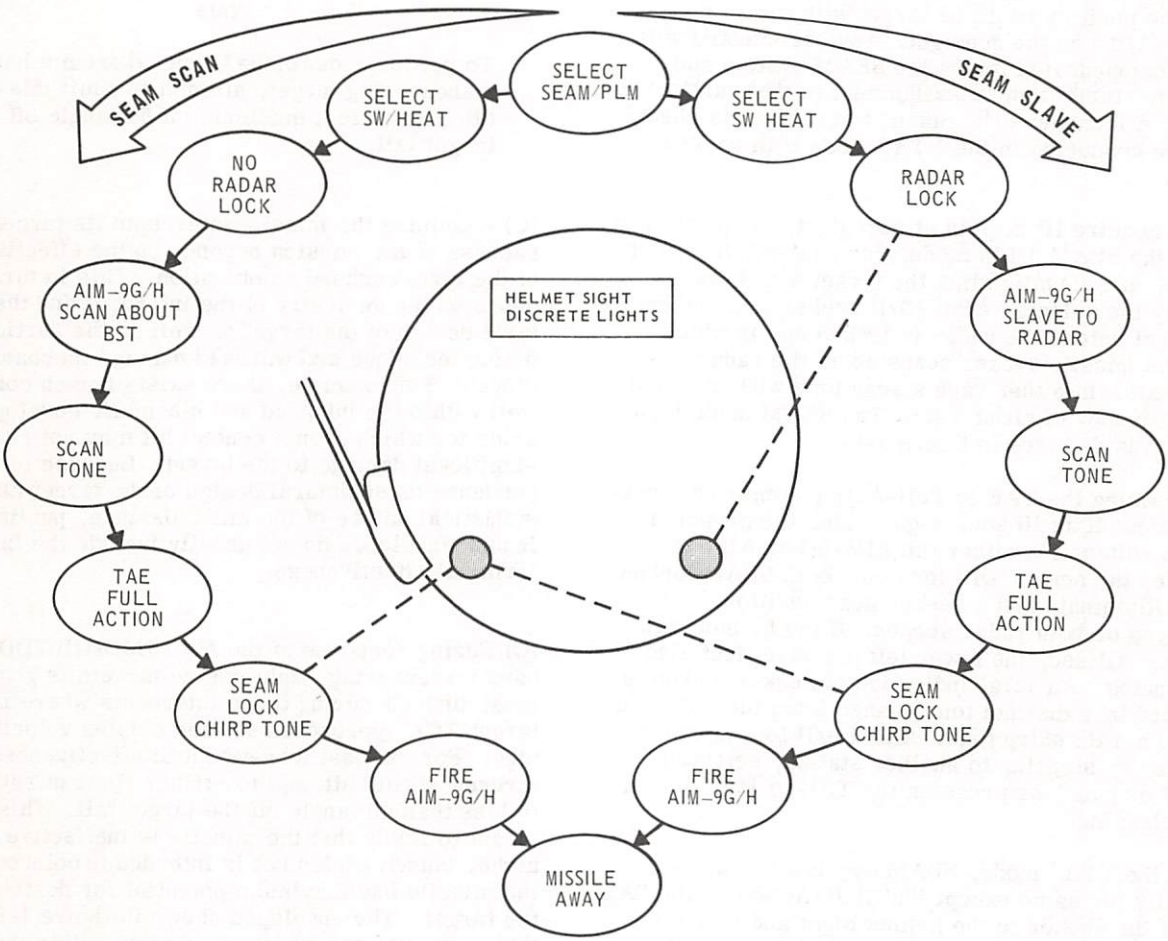


Figure 1-62 (C)

(C) As a rule of thumb, the maximum launch range against a nonmaneuvering target at sea level is 1-2 nautical miles, depending on relative speeds, and increases by 1 nautical mile for each 10,000 feet of altitude. For a differential speed condition, the maximum range is approximated by the formula:

$R_{max} = R_c$ (1 + 0.5 Δ Mach),
where R_c is cospeed R_{max}

(U) At high angles off the target tail, the boundary is often determined by the gimbal limit of the seeker gyro-telescope. Because the missile flies a proportional navigation course, its direction of flight continually changes as aerodynamic drag slows it down and the projected collision point becomes further ahead of the target. This causes the angular separation between the gyro-telescope line of sight and the missile airframe to increase. When the gimbal limit is reached, the seeker loses lock on the target and guidance is terminated. No rule of thumb is available to predict this boundary.

(C) A minimum launch range is required in order that the guidance system have time to correct for any initial launch errors that may exist. These include cross wind, launch aircraft angle of attack, and rocket motor thrust misalignment. Also, for safety reasons, a finite separation is required before the fuze-warhead is armed. For a cospeed tail-on attack the minimum range is 1000 feet. For a differential speed condition, minimum range is approximated by the formula:

$R_{min} = 1000$ (1 + 2 Δ Mach),
where Δ Mach is the differential speed

(C) For firings from angles off the target tail, the minimum range is increased because of the maneuverability limitations of the missile airframe. Although the missile can pull 20G or more, this maneuverability limitation becomes quite significant during close-in, maneuvering engagements. At altitudes below 20,000 feet and high subsonic speeds, minimum range is increased approximately 1000 feet for each 10° of angle off the target tail up to a maximum value of 1 nautical mile. In addition to the airframe maneuverability, the tracking rate capability of the seeker can limit the minimum range boundary under conditions of marginal IR signal level.

(U) One more factor should be considered. The maximum range tail-on is significantly affected by a differential altitude between target and attacker. Because most of the published envelopes are based on target altitude, an altitude disadvantage results in a decrease in the maximum launch range. This is because of the relatively denser air through which the missile must climb to reach the target. On the other hand, an altitude advantage for the attacker increases the launch boundary.

(U) Published envelopes generally reflect nominal missile performance characteristics or are based on conservative assumptions as in the case of roll orientation. Standard atmospheric conditions are used for air density and velocity of sound, but temperature effects on rocket motor performance and other component sensitivities are not ordinarily computed. The effects of initial conditions such as launch aircraft angle of attack are often evaluated as perturbations to more general performance measures. As a consequence, the boundary is not a sharply defined line but a gray area in which the probability of a successful intercept decreases from a high value to zero. For the AIM-9, the width of this region is on the order of 10 percent of the nominal value or 1000 feet, whichever is larger. The aircrew is assured a high probability of successful guidance when firing from within the envelope shown and, in addition, has some degraded probability of success for firings as much as 1000 feet inside the minimum range boundary. VTAS configured aircraft will experience more radar lockons in the ACM environment thereby negating the requirement for range estimation.

Note

DFC computations for AIM-9 are not reliable and should not be utilized until a more accurate launch solution is incorporated.

(U) AIM-9 HANDLING PROCEDURES

(U) To realize optimum performance from the AIM-9 missile system, it is mandatory that certain basic procedures are strictly adhered. These include the following areas:

(U) COOLING

(C) It is imperative that the nitrogen or air cooling system for AIM-9D/G/H be kept free of contaminants at all times to prevent freeze-up of the refrigerated detection unit (RDU). This is particularly true for missile use with the SEAM system. The increase in background audio level associated with reduced cooling raises the noise level at the seeker null and consequently prevents the system from sensing the ratio of target IR signature to background. The result is a scan tone that degrades to a gritty nondistinct tone and finally to the point where lockon cannot be maintained. The AIM-9H, because of its AGC function in the audio circuit which is designed to prevent saturation on very hot targets, is even more sensitive to noise in the scan mode because the AGC function limits its maximum target signature that the missile sees. Therefore, every attempt must be made to meet the specification for purity of the cooling supply (2 parts/million). To approach this requirement, the source of compressed nitrogen/air must obviously be pure but care of the rest of the cooling system is equally important:

a. Always store bottles with protective receiver caps installed.

b. Never allow a nitrogen bottle to bleed below 300 psi. At 0 psi, the bottle is purged to outside air and must be surveyed as contaminated and returned to a NARF for overhaul. Do not recharge the bottle nor enter it into ready supply for re-issue.

c. Maintain protective caps on the forward plug of the LAU-7/A power supply to prevent introduction of moisture and contaminants when a missile umbilical is not installed.

(C)

d. Maintain a charged nitrogen bottle in the LAU-7/A at all times to prevent the entry of contaminants into the power supply (regardless of whether a missile is loaded or not).

(U) MATERIAL CONDITION

(U) Maintain GCG protective caps on all AIM-9 missiles during any ground handling of the missiles or the aircraft on which they are installed. The magnets in the caps are designed to hold the missile seeker in its center position and to prevent its banging the gimbal stop whenever the missile is moved. Since the seeker is electrically caged whenever aircraft or ground power is applied, good practice dictates that the caps be removed once power is applied and reinstalled before it is secured.

(U) TTU-304 IR TESTER

(U) The TTU-304 IR penlight tester is designed to tell the aircrew when the missile is functioning and cooling properly. The filter characteristics of the light are such that the missile will not provide a solid tone during ground checks unless the seeker has cooled to the proper level. Since the wide spectrum and high intensity of a standard flashlight are sufficient to cause a defective missile to appear to be operating and cooling properly, aircrews should insist that the ordnanceman use the TTU-304 IR penlight tester for all missile checks.

AIM-9 QUICK-SHOT REQUIREMENTS

AT TRIGGER SQUEEZE

WEAPONS SYSTEM

1. Audio control – 12-2 o'clock
2. Coolant switch – ON/NORM (AIM-9D/G/H)
3. Missile arm switch – ARM
4. Missile/weapon select switch – HEAT/SW
5. Tone acquisition:
   a. Gunsight on heat source with steady tone.
6. SEAM
   a. VTAS power – ON
   b. Mode – VTAS or SEAM/PLM
   c. Coolant switch – ON/NORM
   d. Missile/Weapon select – HEAT/SW
   e. Audio control – AS DESIRED (both cockpits – F-4J)
   f. Tone acquisition:
      (1) VTAS mode – TAE Half–Action for scan tone (1 Hz). TAE Full–Action for lock tone (4 Hz).
      (2) SEAM/PLM – TAE Half–Action has no function. TAE Full–Action for lock tone. In this mode, the missile seeker slaves to the radar antenna (22° from boresight limit) when radar is in track.
   g. SEAM lights – ILLUMINATED
   h. Radar scope – 20° fixed circle with heat dot display.
   i. Helmet sight – Upper left discrete light indicates coincidence. Lower left discrete light indicates AIM–9 lock.

TRACKING TECHNIQUE

(Gunsight depressed to 35 mils)

1. Missile field of view.
   a. AIM–9D/G/H – 45-mil cone
   b. AIM–9B – 60-mil cone
2. Tone acquisition.
   a. Steady tone – no minimum tracking time required.
   b. Tracking under G – pull 50–75 mils ahead of target. Ease off to steady tone.
   c. Track until missile leaves rail.
   d. SEAM – After lock, target may be tracked up to 40° off boresight. Attempt to fire with pipper–on or with lead. DFC AIM–9 SHOOT indications are not valid.

Note

SIDEWINDER COOLANT LEAKAGE MAY RESULT IN A LOSS OF TONE ON ONE OR MORE AIM–9D/G/H MISSILES. DURING EXTENDED PERIODS OF FLIGHT OCCASIONAL CHECKS FOR TONE ON ALL AIM–9D/G/H MISSILES SHOULD BE MADE.

1. MINIMUM RANGE:

MISSILE RANGE ENVELOPE

NON-MANEUVERING TARGET	AIM–9D/G/H CONTACT FUZE – 1000′ INFLUENCE FUZE – 1000′							AIM–9B CONTACT FUZE – 1000' INFLUENCE FUZE – 3000'
MANEUVERING TARGET	TCA – DEGREES							LAUNCH WITHIN 25° ANGLE OFF AT LAUNCH G OF 2 OR LESS
	0	10	20	30	40	50	60	
	1000	2000	3000	4000	5000	6000	7000	
	RANGE – FEET (LAUNCH AIRCRAFT UP TO 6.5G)							

2. MAXIMUM RANGE:

AIM–9D/G/H	AIM–9B
1–2 miles at sea level. Increases 1 NM for each 10,000 feet of altitude	1 mile at sea level. Increases 1/2 NM for each 10,000 feet of altitude

NOTES

1. Radar malfunctions do not affect AIM–9 launch capability.
2. Do not ripple fire AIM–9. SHOOT-LOOK-SHOOT.
3. Gun switch must be OFF.
4. Radar power and interlock switch have no effect on AIM–9.

CONFIDENTIAL

FDB–1T–(72)

Figure 1-63 (C)

GUNSIGHT TRACKING

Note

MIL LEADS COMPUTED FOR 1500 FEET FIRING RANGE AND ARE VALID ONLY WHEN MK 4 GUNPOD IS BORESIGHTED PARALLEL TO THE FRL.

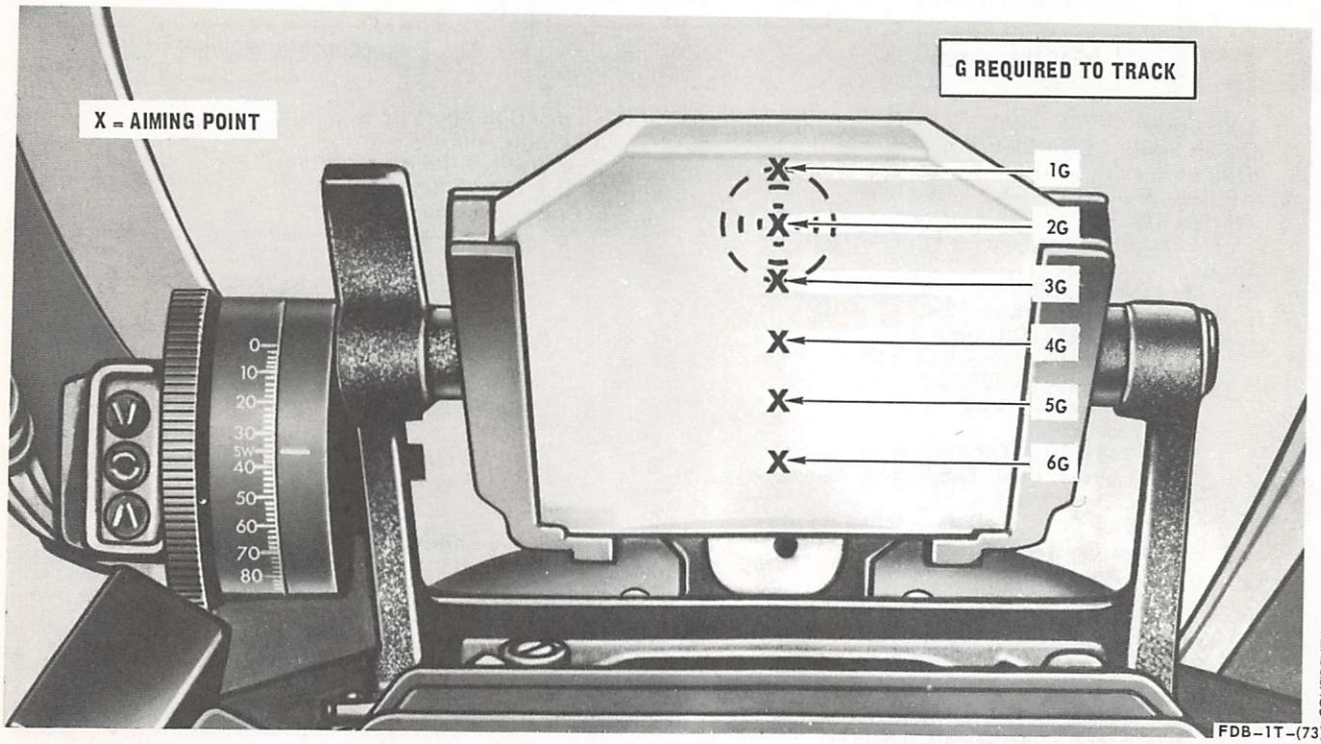


Figure 1-64 (C)

AIR-TO-AIR EMPLOYMENT OF MK4 GUN POD

(U) GENERAL

Note

Carrying the gunpod in an air-to-air situation is not recommended unless an honest evaluation of the gunpod maintenance effort indicates a good probability of fireout.

(C) Although designed for use as an air-to-ground weapon, the Mk 4 gunpod has an application in an air-to-air environment. Before a decision is made to carry it in such a role, the following factors should be considered:

ADVANTAGES

a. A close-in weapon.
b. High cyclic rate of fire (4000 rpm in fast mode).
c. Broad carriage (750 KCAS and 6.5G) and firing (750 KCAS and 6.0G) limits.
d. All four fuselage AIM-7 missiles can be safely fired.
e. Can be used air-to-ground on same flight.

DISADVANTAGES

a. Poor reliability plus large maintenance effort required.
b. Lack of lead computing gunsight makes correct mil lead estimation difficult.
c. No precise range information available to pilot.
d. Boresight changes through fireout.
e. Extra weight (1406 pounds loaded, 803 pounds empty) reduces fuel available for carrier recoveries.
f. Gunpod flexes on airframe during maneuvers causing wider dispersion pattern.

(U) GUNSIGHT TRACKING

(U) Although a larger number of variables are involved in achieving a correct gun tracking solution, the most important one to the pilot is estimating the correct mil lead on the target. The amount of mil lead is a function of TCA, or put another way, a function of G required to track the target. As a rule of thumb, at recommended ACM altitudes and within minimum missile range, add 25-30 mils for each G required to track. In an air-to-air environment, the gunsight is logically set at 35 mils, which happens to be the mil lead for a 2 G tracking solution. Therefore, it may help to imagine each additional G mil lead as one more gunsight reticle ring radius (figure 1-64).

VISUAL ESTIMATION OF RANGE

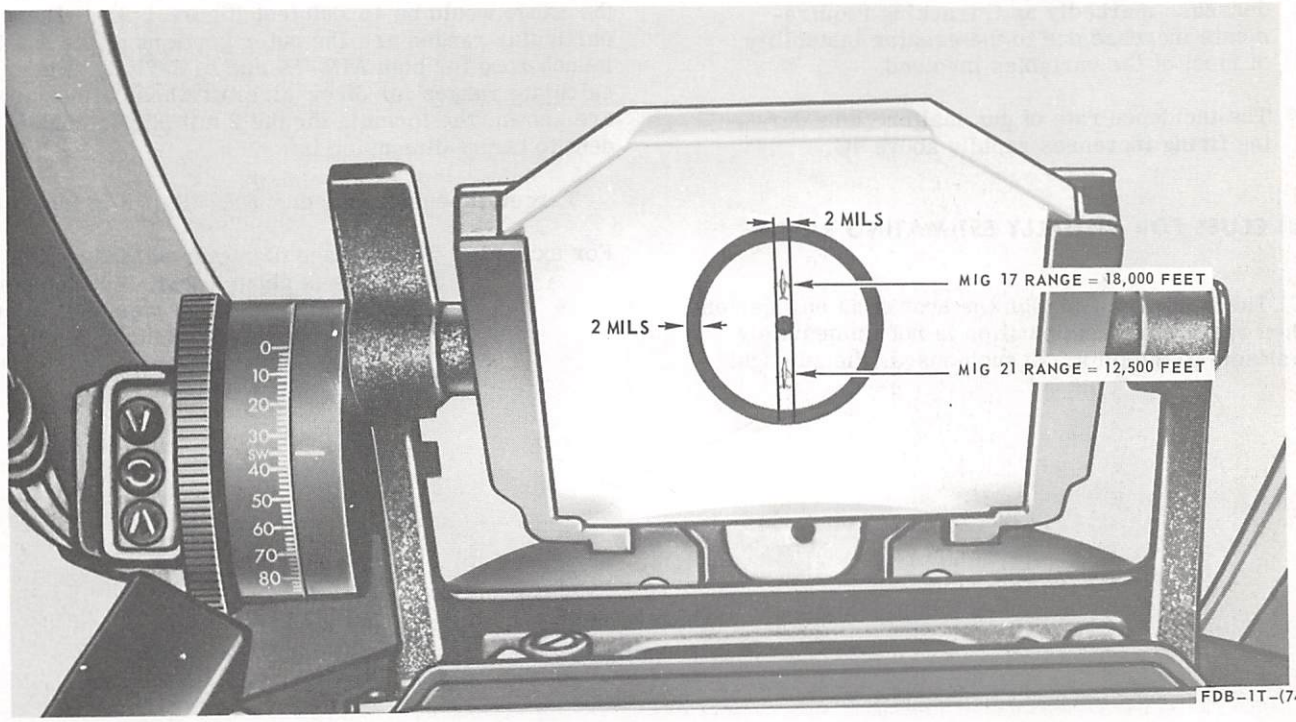


Figure 1-65 (C)

(U) RANGE ESTIMATION

(C) It is not recommended that the gunpod be fired beyond minimum missile range. Since the F-4 is not well suited to close-in fighting with MIG series aircraft, serious consideration must be made regarding the aggressiveness of the enemy pilot and the tactical situation at the moment before deciding to press a gun attack. Hit probabilities increase as range decreases, particularly within 2000 feet. Against MIG series aircraft, you will be within 2000 feet when the 2 mil gunsight pipper is smaller than the enemy's fuselage diameter.

(U) FIRING TECHNIQUES

(C) It is recommended that every tenth round loaded be a tracer. This will give about seven tracers per second in the fast firing mode, which is the only recommended mode. The weapon switch should be placed to CONV ON-NUCL OFF before entering the engagement area. On F-4B/N and F-4J before cockpit optimization, as you pass within minimum missile range, select READY with the guns switch. On F-4J with cockpit optimization, select GN with the control stick weapon select switch and place the gun/missile arm switch to ARM. Maneuver the aircraft using your estimate of the mil lead to a smooth and steady track on the largest portion of the enemy aircraft.

Note

With the gun switch in READY or weapon select switch in GN (F-4J with cockpit optimization), the missile firing circuits are cut out of the stick grip trigger. On aircraft with the dogfight computer, the dogfight computer solutions are not presented when guns are selected.

(C) For practical purposes, it is not necessary to correct for gravity drop at these ranges (1.5 foot drop per 1000 feet range) due to the nominally wide dispersion of the gunpod (8 feet at 1000 feet range) and additional lateral dispersions of up to 25 mils caused by the gunpod flexing on its mounts during maneuvering. Press the trigger for a short burst and observe the tracers. At these ranges, tracer and HEI ballistic differences are not significant. Should your first burst hit, another burst may not be required. If not, reposition and fire another burst. This shoot-look-shoot technique with tracers has proved very effective against maneuvering dart targets. Another technique which could be used in very high TCA situations where steady tracking is not possible, is to fire a long burst across the flight path of the enemy in the hope that he may fly through the rounds. Even if the rounds do not hit, the psychological shock to the enemy pilot at seeing a large cluster of tracers in his area, may cause him to make a mistake which can be capitalized upon.

Note

- Historically, it is of interest to note that the vast majority of gun kills in all wars were non-maneuvering on unsuspecting targets shot at low angles off. Kill probabilities decrease markedly as G tracking requirements increase due to the greater instability of most of the variables involved.
- The incidence rate of gun malfunctions during firing increases rapidly above 4G.

(U) CLUES FOR VISUALLY ESTIMATING RANGE

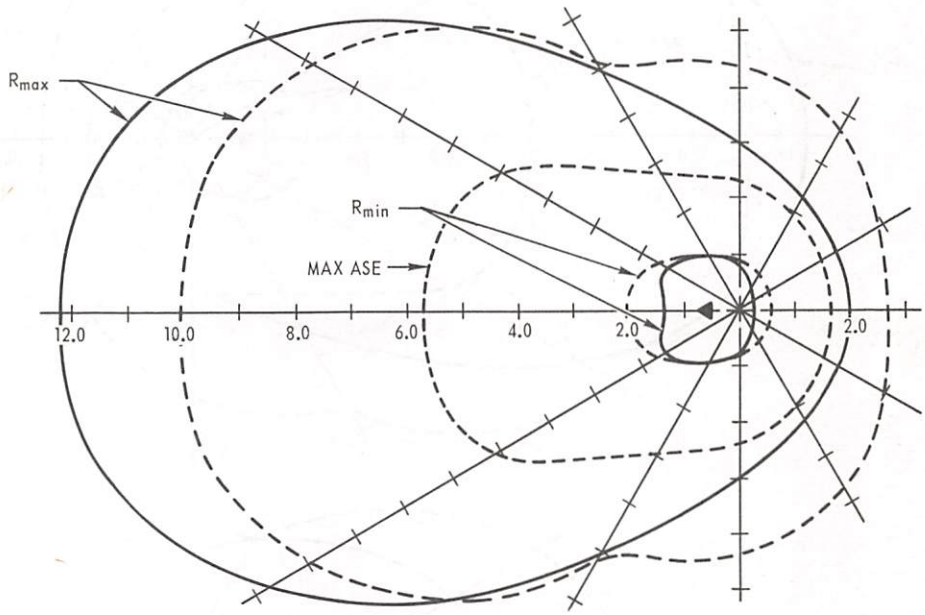
(C) There may be times in the heat of an engagement when radar range information is not immediately available to the pilot. In such cases, the gunsight can be used to estimate range. Both the pipper and circular reticle lines are 2 mils wide. Accordingly, if an enemy's wingspan is known, range can be estimated by comparing wingspan to pipper or reticle line width. If a MIG-21 wingspan is concident to pipper width, range is 12,500 feet. For a MIG-17, the range would be 18,000 feet (figure 1-65). These particular ranges are the outer portions of the ACM launch zone for both AIM-7E and AIM-7E-2. To calculate ranges for other aircraft whose dimensions are known, the formula for the 2 mil pipper coincident to target dimension is:

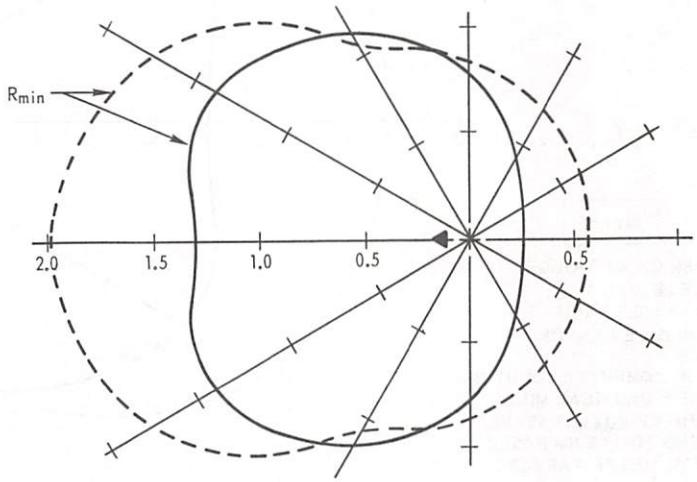
Target dimension in feet x 500 = Range in feet.

For example: The average diameter of MIG series fuselages is about 4 feet. With pipper width equal to fuselage diameter, slant range can be estimated thus: 4 feet x 500 = 2000 feet slant range.

AIM-7E-2 NON-MANEUVERING ENVELOPES

5 000 FEET





Notes

1. PIPPER ON AT TRIGGER SQUEEZE
2. $V_F = V_T = 0.7$ MACH
3. ____MISSILE PERFORMANCE
4. _ _ _1G COMPUTER SOLUTION
5. RANGE = NAUTICAL MILES

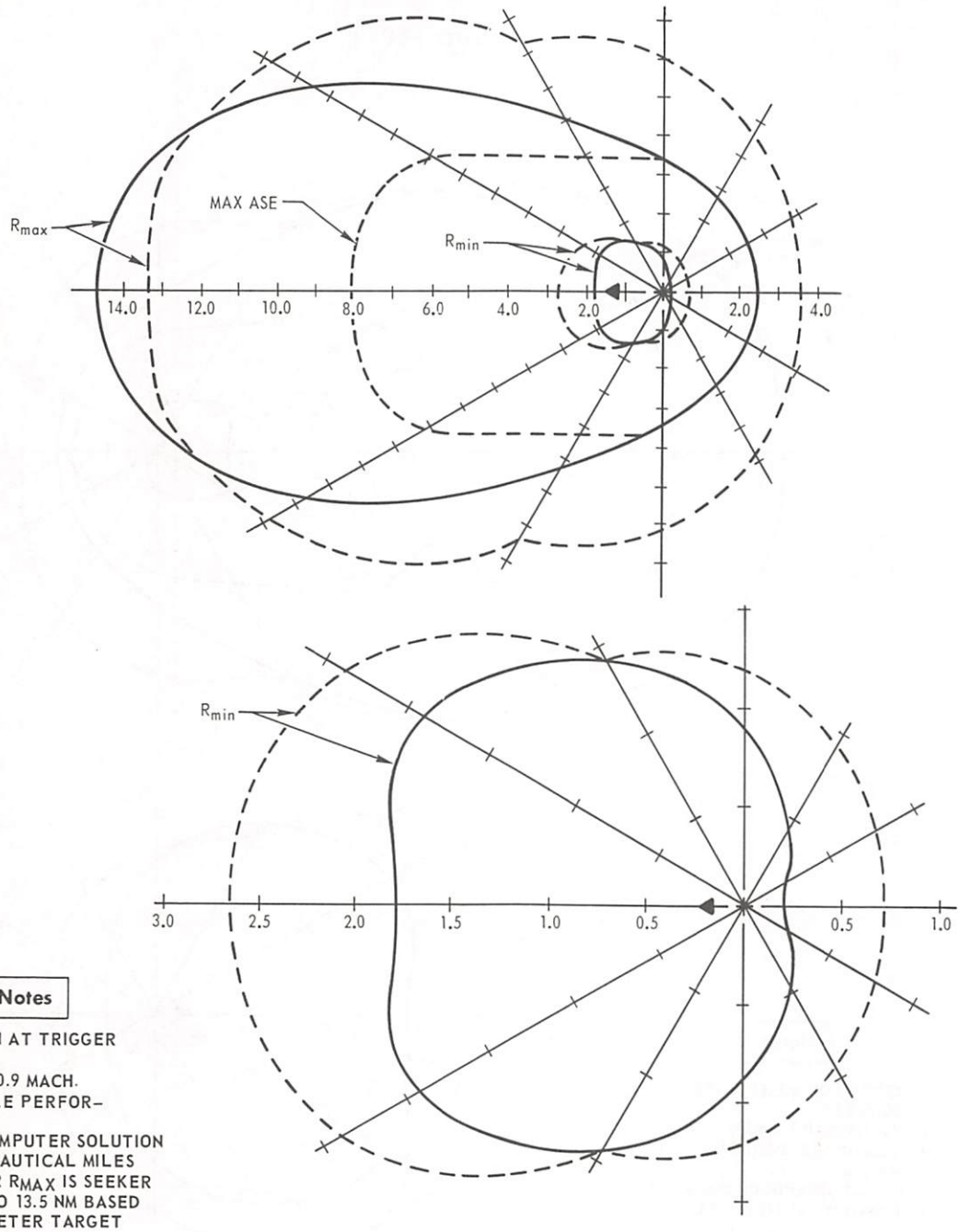
CONFIDENTIAL

FDB-1T-(75-1)

Figure 1-66 (C) (Sheet 1 of 4)

AIM-7E-2 NON-MANEUVERING ENVELOPES- CONTINUED

15,000 FEET



Notes

1. PIPPER ON AT TRIGGER SQUEEZE
2. $V_F = V_T = 0.9$ MACH.
3. ——MISSILE PERFORMANCE
4. – – –1G COMPUTER SOLUTION
5. RANGE = NAUTICAL MILES
6. COMPUTER R_{MAX} IS SEEKER LIMITED TO 13.5 NM BASED ON 2 SQ. METER TARGET

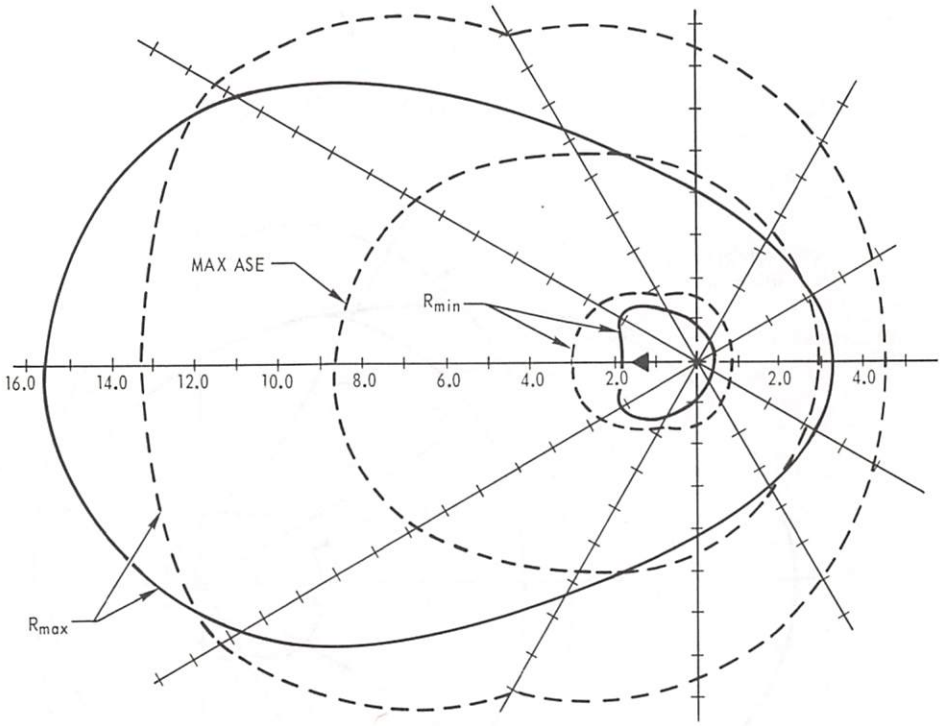
CONFIDENTIAL

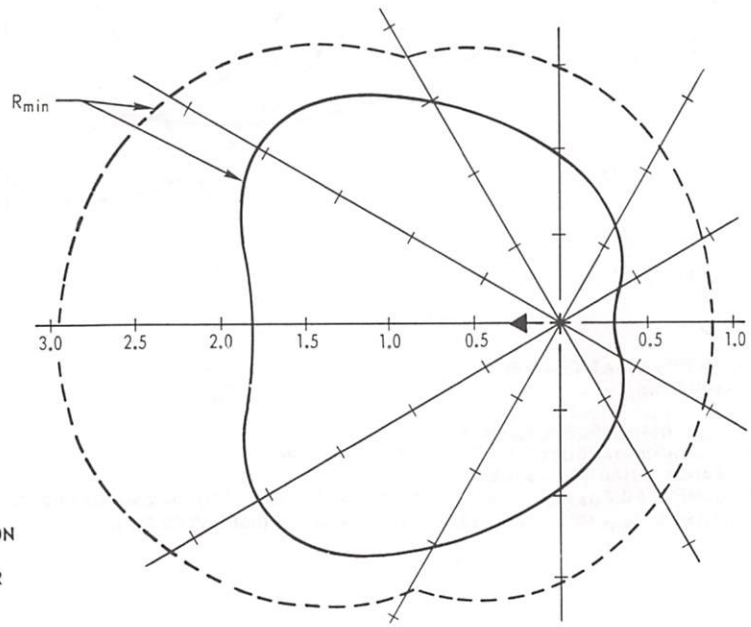
FDB-1T-(75-2)

Figure 1-66 (C) (Sheet 2 of 4)

AIM-7E-2 NON-MANEUVERING ENVELOPES-CONTINUED

25,000 FEET





Notes

1. PIPPER ON AT TRIGGER SQUEEZE
2. $V_F = V_T = 0.9$ MACH
3. ___ MISSILE PERFORMANCE
4. - - - 1G COMPUTER SOLUTION
5. RANGE = NAUTICAL MILES
6. COMPUTER R_{MAX} IS SEEKER LIMITED TO 13.5 NM BASED ON 2 SQ. METER TARGET

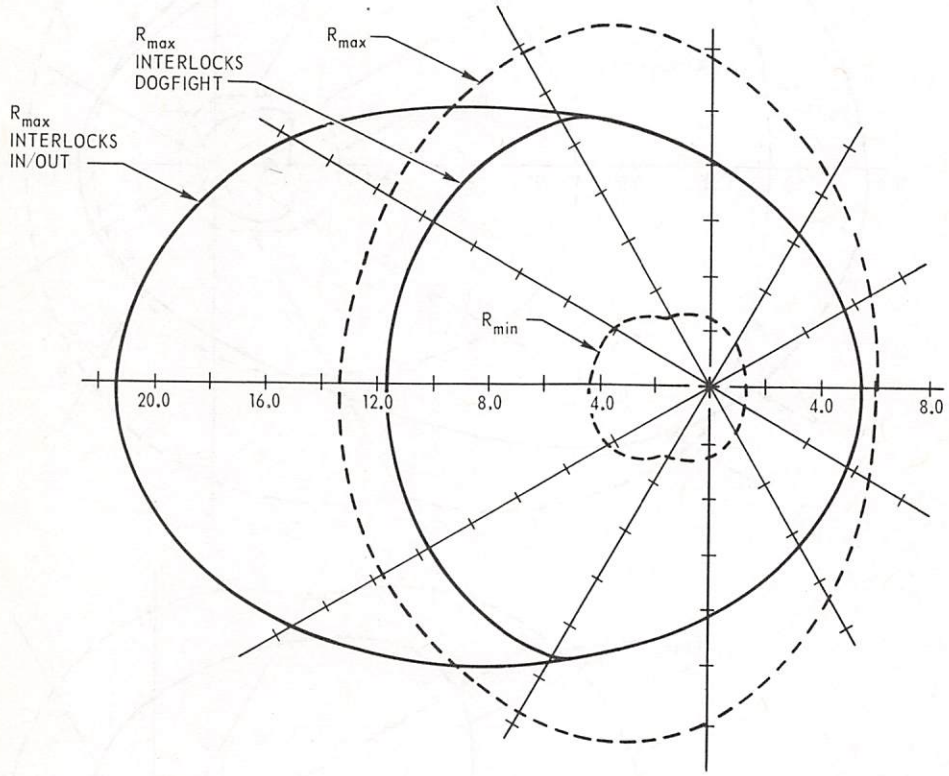
CONFIDENTIAL

FDB-1T-(75-3)

Figure 1-66 (C) (Sheet 3 of 4)

AIM-7E-2 NON-MANEUVERING ENVELOPES-CONTINUED

40,000 FEET



Notes

1. PIPPER ON AT TRIGGER SQUEEZE
2. $V_F = V_T = 1.4$ MACH
3. ___ MISSILE PERFORMANCE
4. - - - NON-MANEUVERING COMPUTER SOLUTION
5. RANGE = NAUTICAL MILES
6. COMPUTED R_{MAX} IS SEEKER LIMITED TO 13.5 NM BASED ON 2 SQ. METER TARGET
7. MISSILE R_{MIN} NOT DISPLAYED. USE COMPUTER DISPLAYED R_{MIN}

CONFIDENTIAL

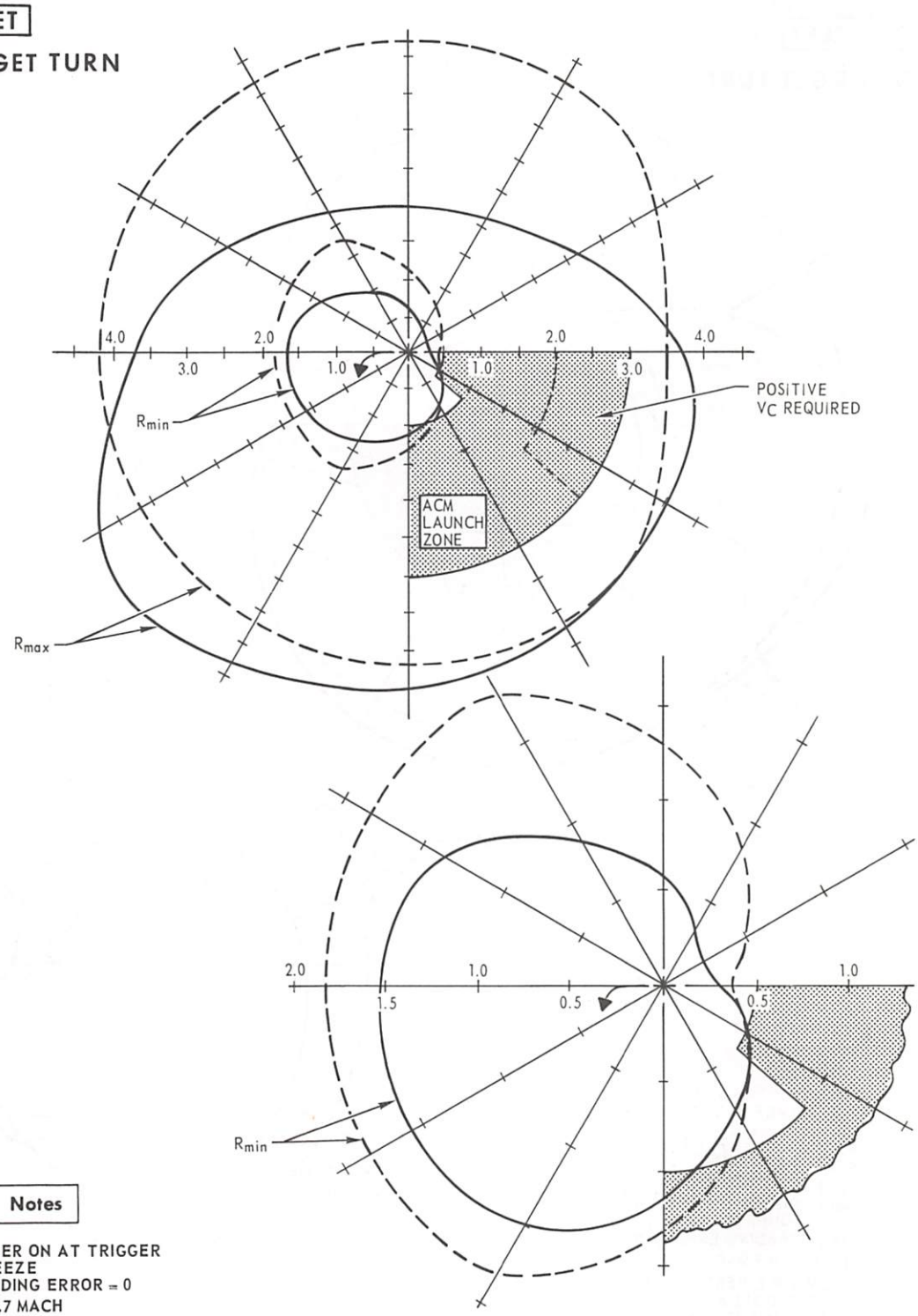
FBD-1T-(75-4)

Figure 1-66 (C) (Sheet 4 of 4)

AIM-7E-2 MANEUVERING ENVELOPE

5000 FEET

4.5G TARGET TURN



Notes

1. R_{MIN}: PIPPER ON AT TRIGGER SQUEEZE
2. R_{MAX}: HEADING ERROR = 0
3. $V_F = V_T = 0.7$ MACH
4. ____ MISSILE PERFORMANCE
5. _ _ _ DFC DISPLAYED ENVELOPE
6. RANGE = NAUTICAL MILES

CONFIDENTIAL

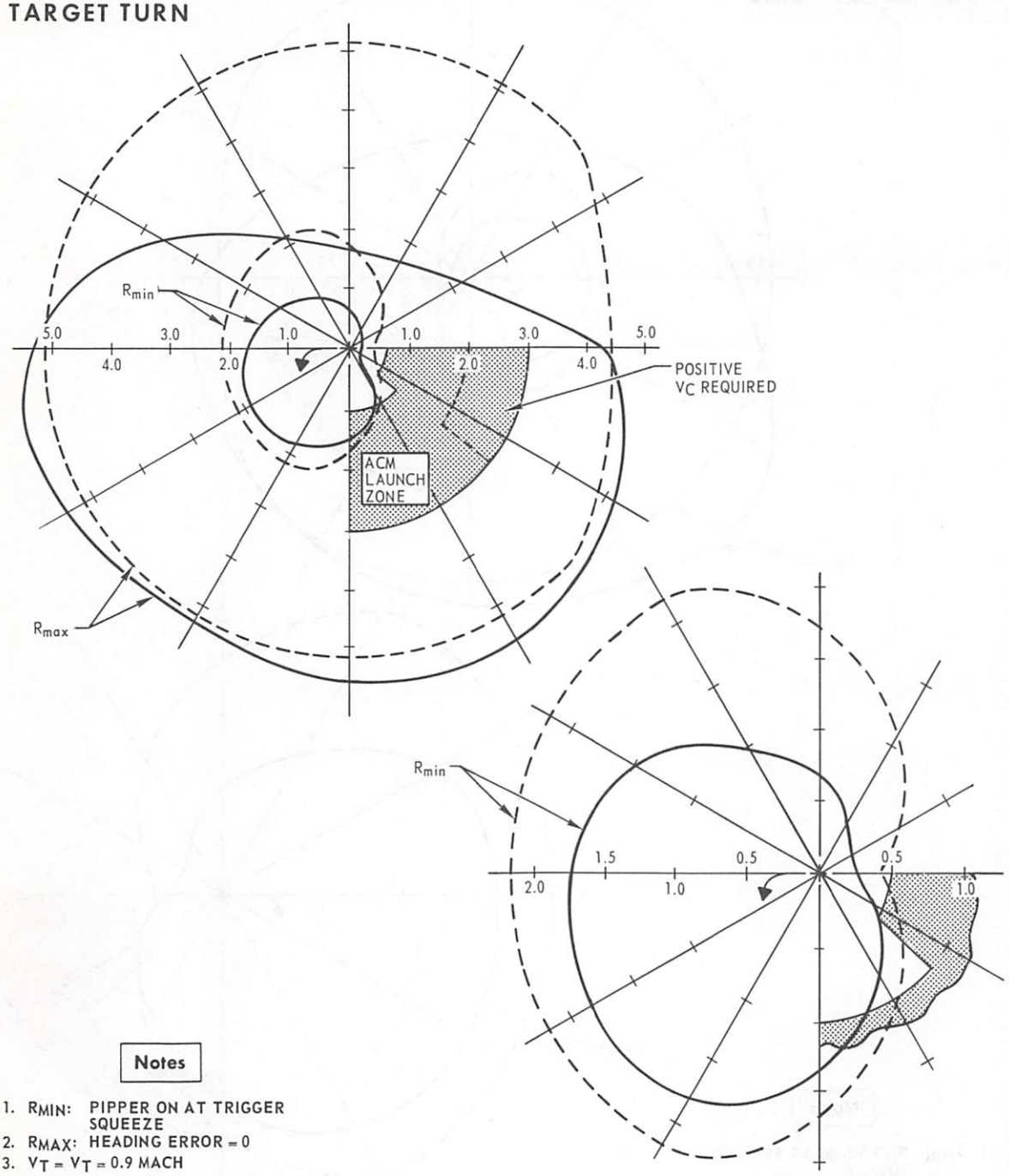
FDB-1T-(77-1)

Figure 1-67 (C) (Sheet 1 of 3)

AIM-7E-2 MANEUVERING ENVELOPES-CONTINUED

15,000 FEET

4.5G TARGET TURN



Notes

1. R_{MIN}: PIPPER ON AT TRIGGER SQUEEZE
2. R_{MAX}: HEADING ERROR = 0
3. $V_T = V_T = 0.9$ MACH
4. ____MISSILE PERFORMANCE
5. _ _ _DFC DISPLAYED ENVELOPE
6. RANGE = NAUTICAL MILES

CONFIDENTIAL

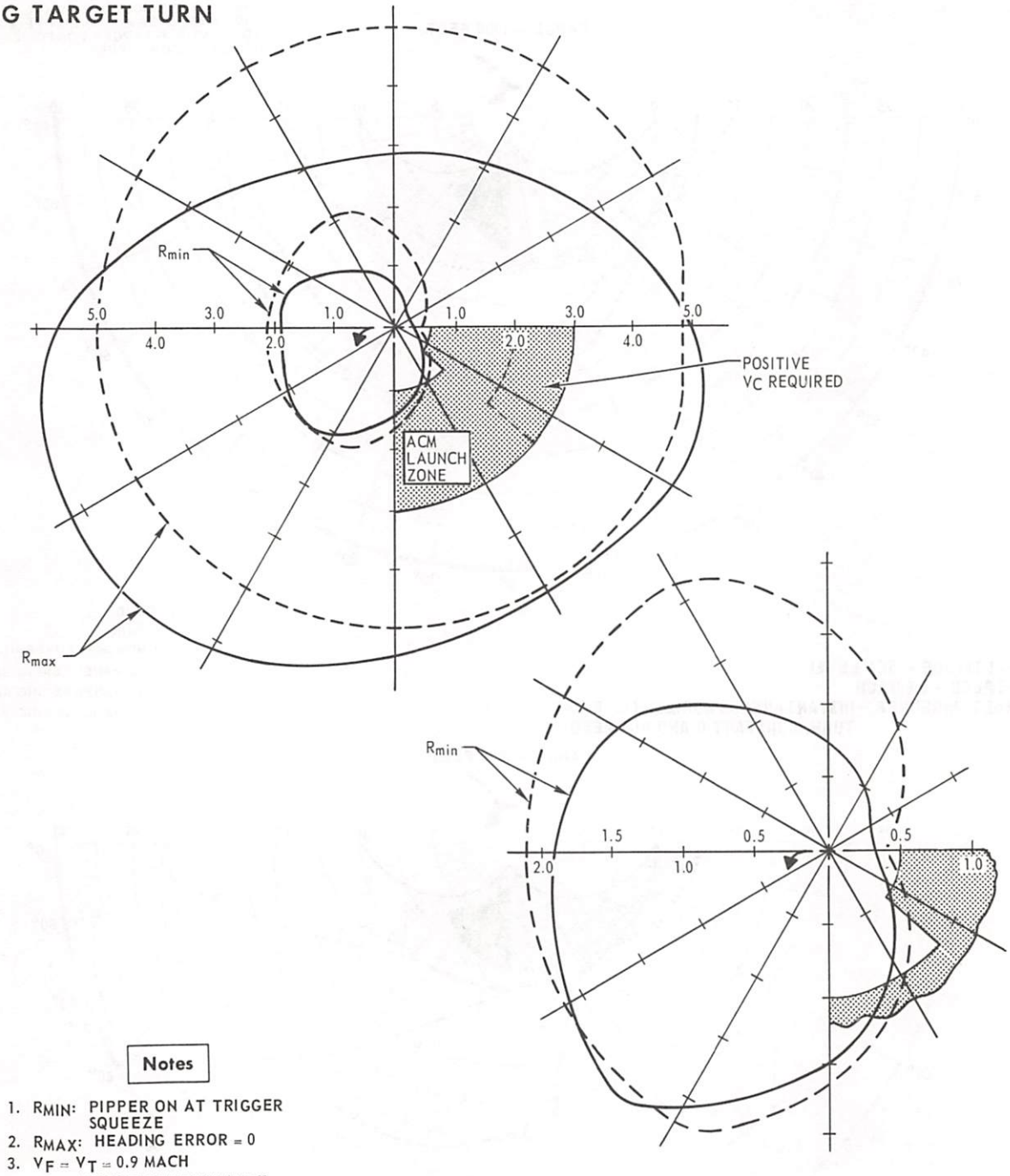
FDB-1T-(77-2)

Figure 1-67 (C) (Sheet 2 of 3)

AIM-7E-2 MANEUVERING ENVELOPE-CONTINUED

25,000 FEET

4.5G TARGET TURN



Notes

1. R_{MIN}: PIPPER ON AT TRIGGER SQUEEZE
2. R_{MAX}: HEADING ERROR = 0
3. $V_F = V_T = 0.9$ MACH
4. ____MISSILE PERFORMANCE
5. ___DFC DISPLAYED ENVELOPE
6. RANGE = NAUTICAL MILES

FDB-1T-(77-3) CONFIDENTIAL

Figure 1-67 (C) (Sheet 3 of 3)

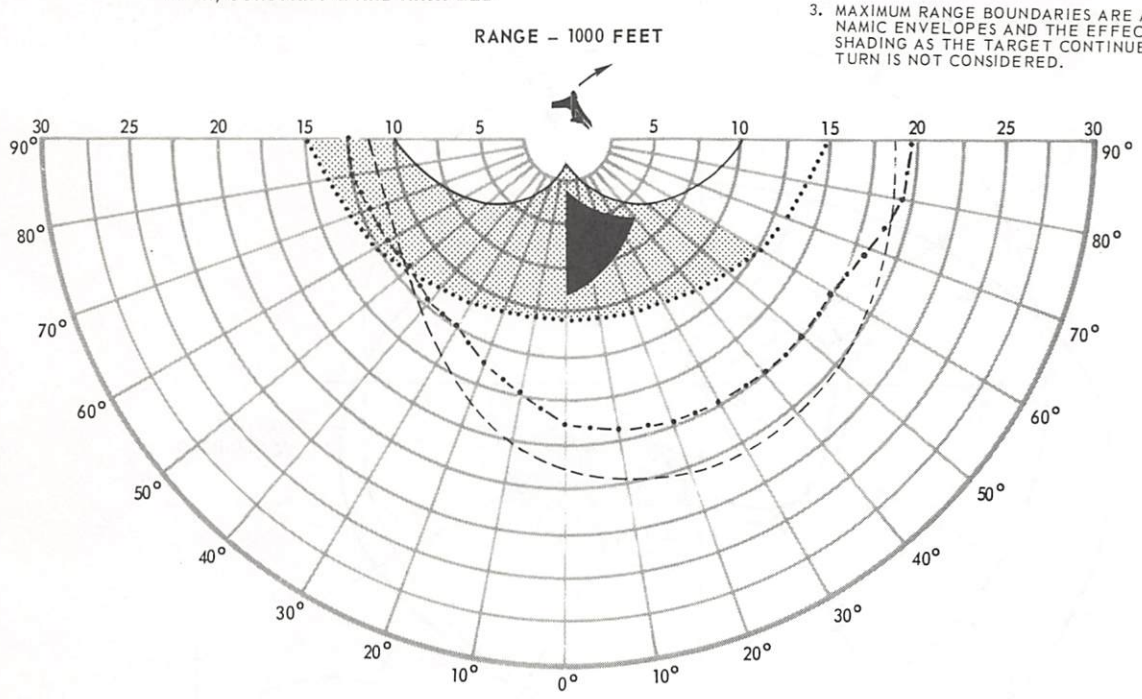
AIM-9D/G LAUNCH ENVELOPES

MANEUVERING AND NON-MANEUVERING TARGET

Notes

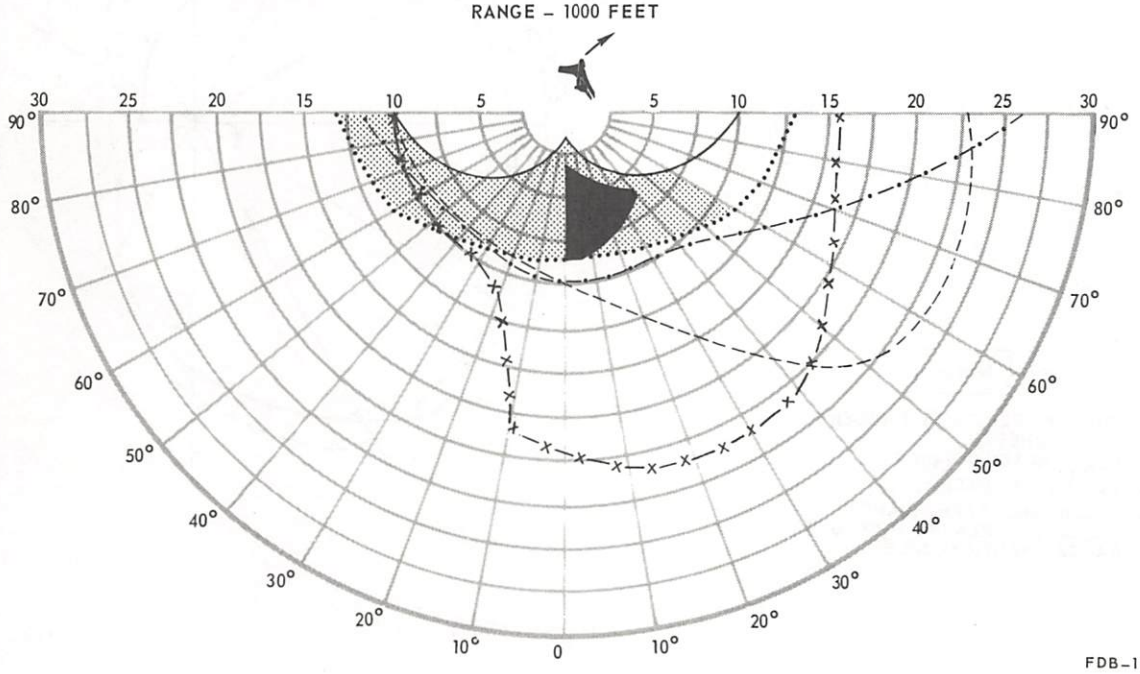
1. ALL G ARE TARGET G MEASURED IN HORIZONTAL PLANE.
2. RECOMMEND FIRING ONLY IN HEAVY SHADED AREA BECAUSE OF DIFFICULTY IN DETERMINING ASPECT AND RANGE OF UNFAMILIAR BOGEY IN MANEUVERING ENVIRONMENT. HOWEVER, MISSILE HAS LETHAL CAPABILITY IN COMPLETE SHADED AREA.
3. MAXIMUM RANGE BOUNDARIES ARE AERODYNAMIC ENVELOPES AND THE EFFECTS OF IR SHADING AS THE TARGET CONTINUES ITS TURN IS NOT CONSIDERED.

CO-ALTITUDE – SEA LEVEL
CO-SPEED – 0.6 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED



LEGEND
——— R_{MIN}
••••••• NON-MANEUVERING R_{MAX}
–•–•– 3G MANEUVERING R_{MAX}
– – – – 5G MANEUVERING R_{MAX}
–X–X– 7G MANEUVERING R_{MAX}

CO-ALTITUDE – SEA LEVEL
CO-SPEED – 0.8 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED



CONFIDENTIAL

FDB-1T-(78-1)

Figure 1-68 (C) (Sheet 1 of 5)

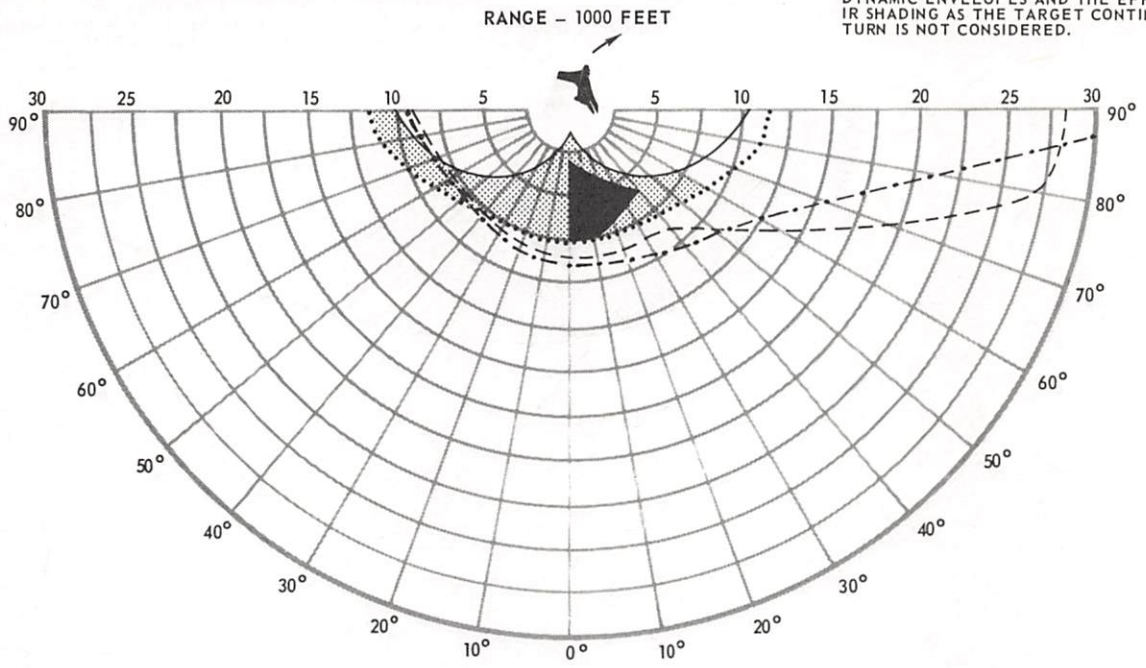
AIM-9D/G LAUNCH ENVELOPES

MANEUVERING AND NON-MANEUVERING TARGET

CO-ALTITUDE – SEA LEVEL
CO-SPEED – 1.0 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED

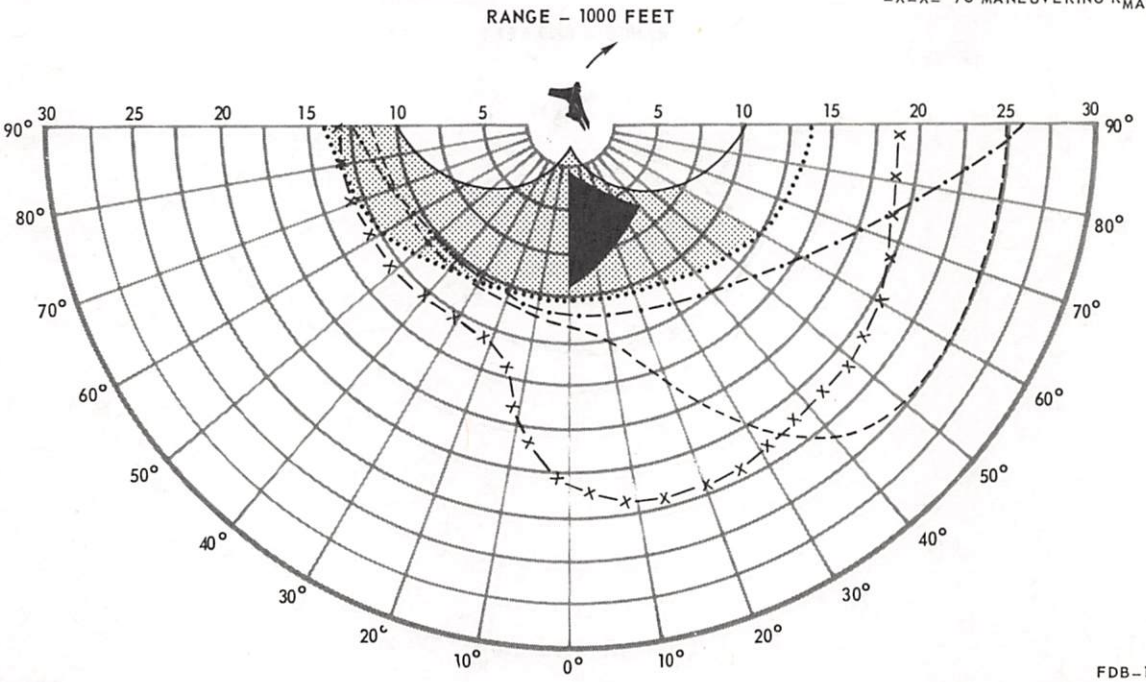
Notes

1. ALL G ARE TARGET G MEASURED IN HORIZONTAL PLANE.
2. RECOMMEND FIRING ONLY IN HEAVY SHADED AREA BECAUSE OF DIFFICULTY IN DETERMINING ASPECT AND RANGE OF UNFAMILIAR BOGEY IN MANEUVERING ENVIRONMENT. HOWEVER, MISSILE HAS LETHAL CAPABILITY IN COMPLETE SHADED AREA.
3. MAXIMUM RANGE BOUNDARIES ARE AERODYNAMIC ENVELOPES AND THE EFFECTS OF IR SHADING AS THE TARGET CONTINUES ITS TURN IS NOT CONSIDERED.



CO-ALTITUDE – 5,000 FEET
CO-SPEED – 0.8 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED

LEGEND
- ——— R_{MIN}
- ····· NON-MANEUVERING R_{MAX}
- —·—·— 3G MANEUVERING R_{MAX}
- – – – – 5G MANEUVERING R_{MAX}
- –X–X– 7G MANEUVERING R_{MAX}



CONFIDENTIAL

FDB-1T-(78-2)

Figure 1-68 (C) (Sheet 2 of 5)

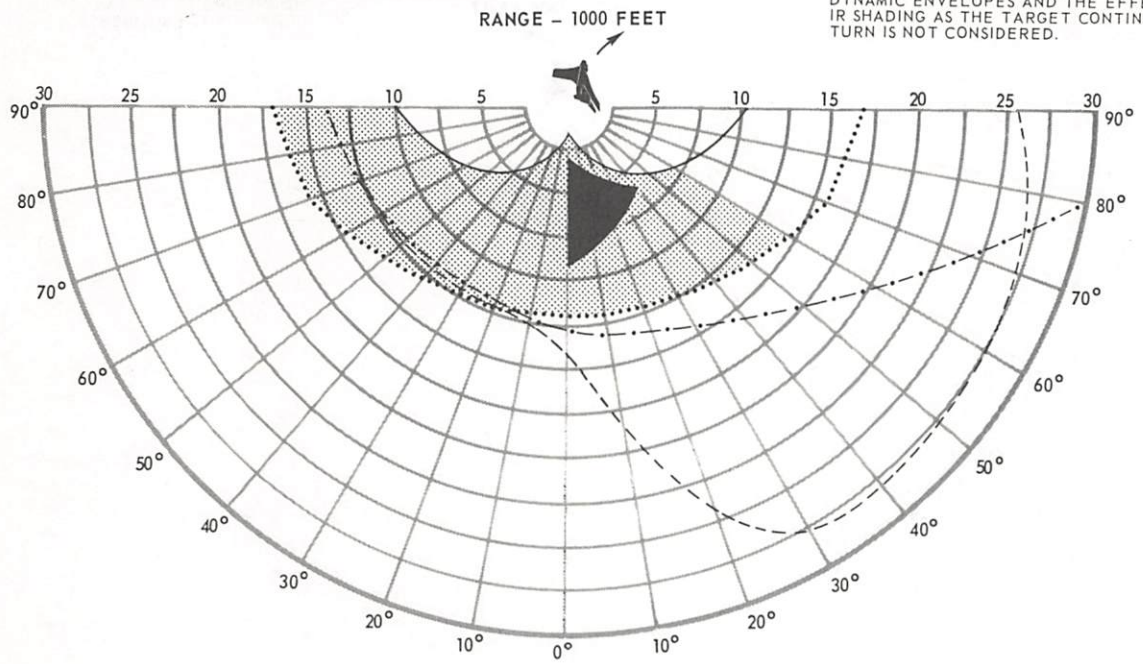
AIM-9D/G LAUNCH ENVELOPES

MANEUVERING AND NON-MANEUVERING TARGET

CO-ALTITUDE – 10,000 FEET
CO-SPEED – 0.8 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED

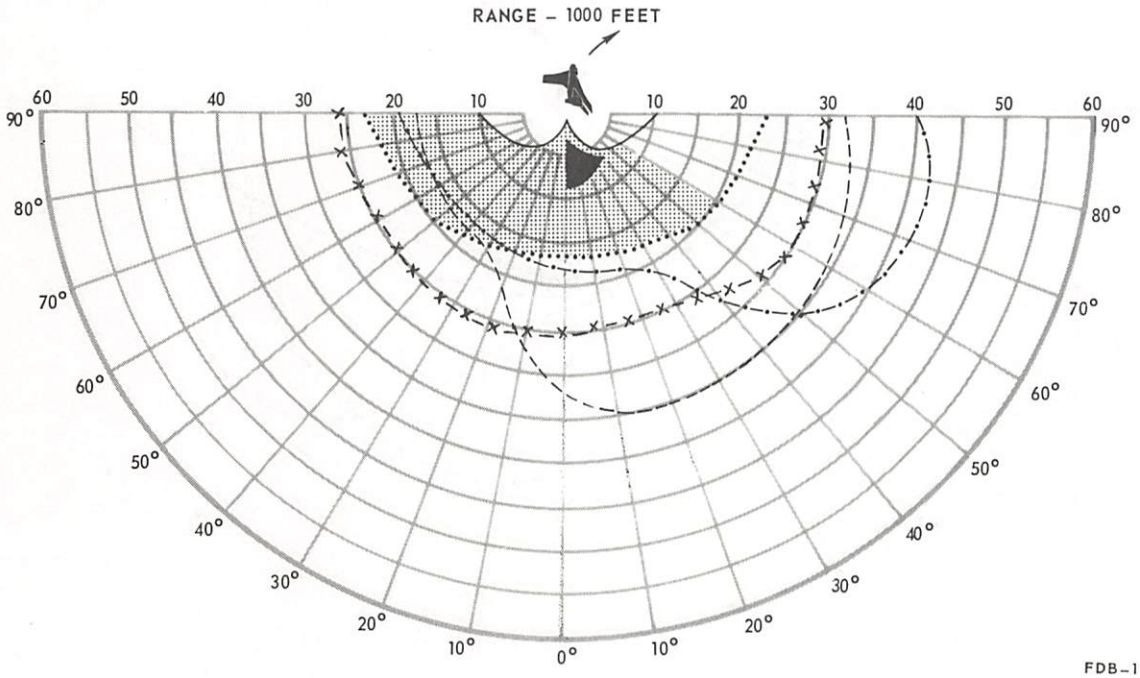
Notes

1. ALL G ARE TARGET G MEASURED IN HORIZONTAL PLANE.
2. RECOMMEND FIRING ONLY IN HEAVY SHADED AREA BECAUSE OF DIFFICULTY IN DETERMINING ASPECT AND RANGE OF UNFAMILIAR BOGEY IN MANEUVERING ENVIRONMENT. HOWEVER, MISSILE HAS LETHAL CAPABILITY IN COMPLETE SHADED AREA.
3. MAXIMUM RANGE BOUNDARIES ARE AERODYNAMIC ENVELOPES AND THE EFFECTS OF IR SHADING AS THE TARGET CONTINUES ITS TURN IS NOT CONSIDERED.



CO-ALTITUDE – 20,000 FEET
CO-SPEED – 0.8 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED

LEGEND
- ——— R_{MIN}
- ····· NON-MANEUVERING R_{MAX}
- —·—·— 3G MANEUVERING R_{MAX}
- – – – 5G MANEUVERING R_{MAX}
- X–X–X– 7G MANEUVERING R_{MAX}



CONFIDENTIAL

FDB-1T-(78-3)

Figure 1-68 (C) (Sheet 3 of 5)

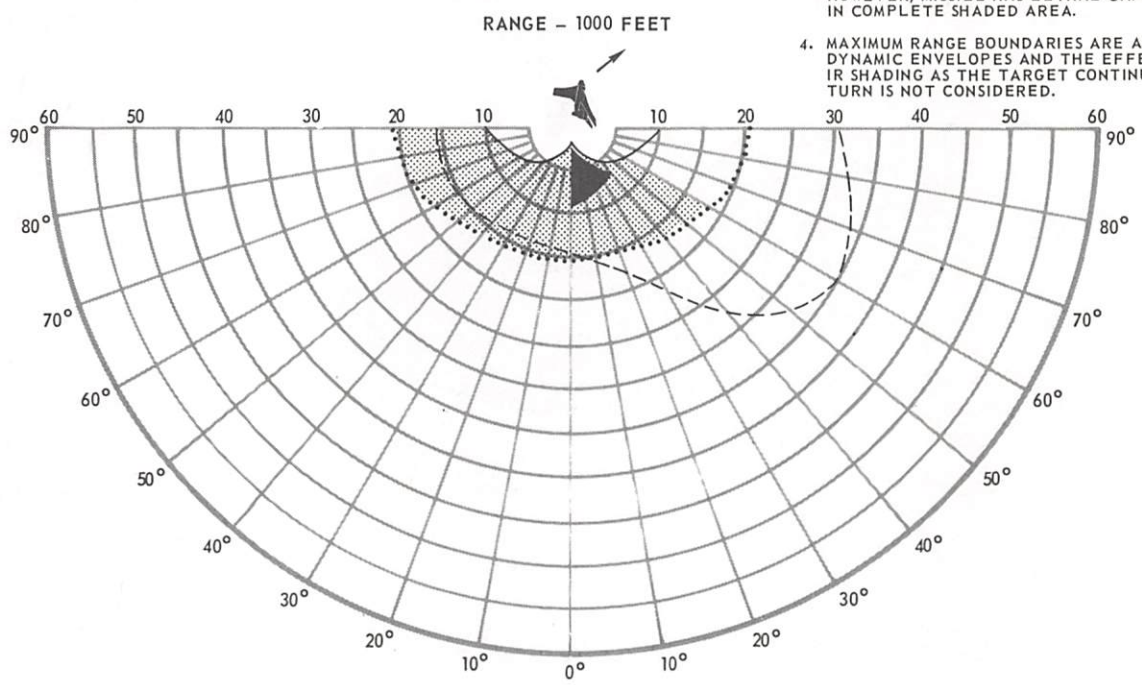
AIM-9D/G LAUNCH ENVELOPES

MANEUVERING AND NON-MANEUVERING TARGET

CO–ALTITUDE – 20,000 FEET
CO–SPEED – 1.0 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED

Notes

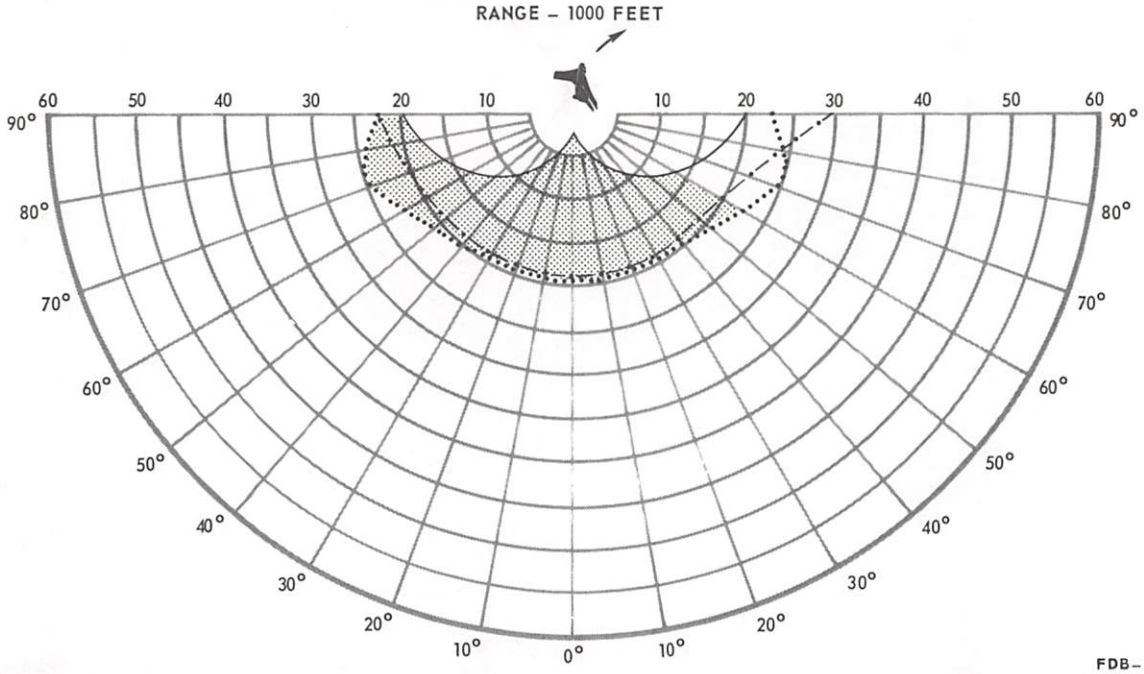
1. ALL G ARE TARGET G MEASURED IN HORIZONTAL PLANE.
2. THE MINIMUM RANGE ABOVE 20,000 FEET IS DOUBLE THE LOW ALTITUDE THUMB RULE.
3. RECOMMEND FIRING ONLY IN HEAVY SHADED AREA BECAUSE OF DIFFICULTY IN DETERMINING ASPECT AND RANGE OF UNFAMILIAR BOGEY IN MANEUVERING ENVIRONMENT. HOWEVER, MISSILE HAS LETHAL CAPABILITY IN COMPLETE SHADED AREA.
4. MAXIMUM RANGE BOUNDARIES ARE AERODYNAMIC ENVELOPES AND THE EFFECTS OF IR SHADING AS THE TARGET CONTINUES ITS TURN IS NOT CONSIDERED.



LEGEND

——— R_{MIN}
····· NON–MANEUVERING R_{MAX}
–·–·– 3G MANEUVERING R_{MAX}
– – – – 5G MANEUVERING R_{MAX}

CO–ALTITUDE – 30,000 FEET
CO–SPEED – 1.2 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED



CONFIDENTIAL

FDB–1T–(78–4)

Figure 1-68 (C) (Sheet 4 of 5)

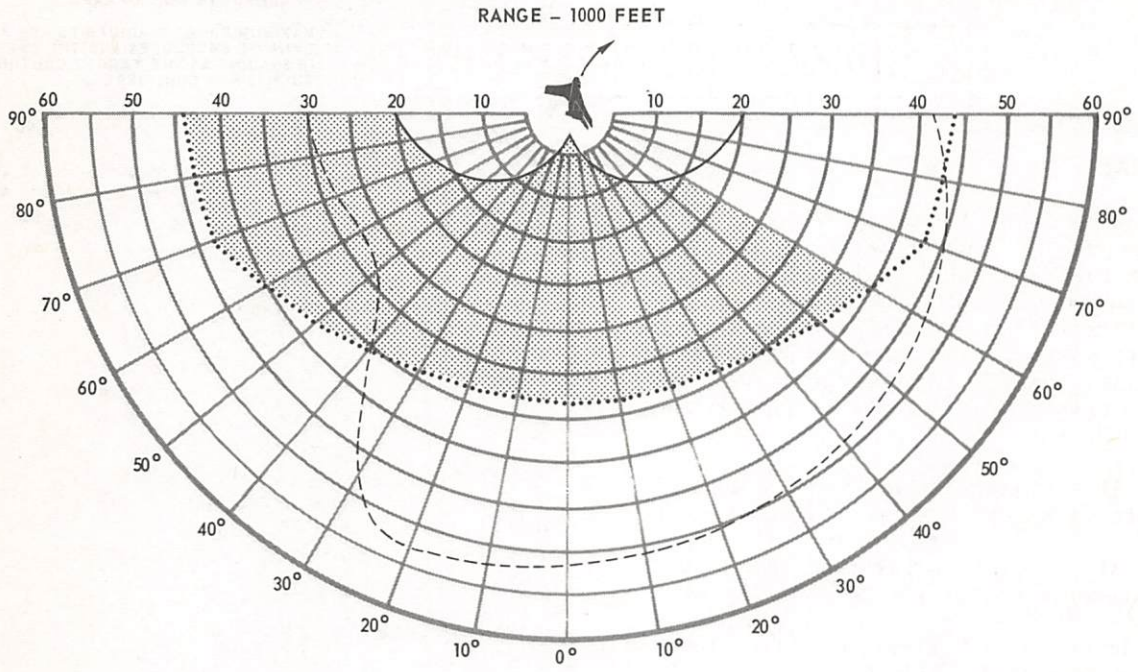
AIM-9D/G LAUNCH ENVELOPES

MANEUVERING AND NON-MANEUVERING TARGET

Notes

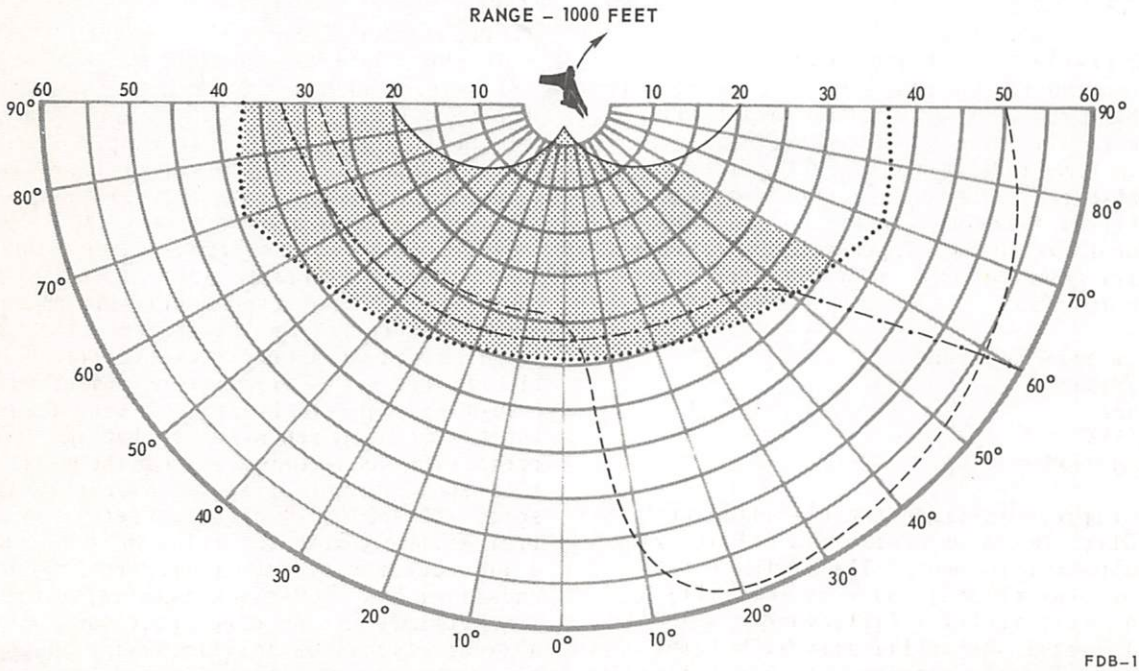
1. ALL G ARE TARGET G MEASURED IN HORIZONTAL PLANE.
2. THE MINIMUM RANGE ABOVE 20,000 FEET IS DOUBLE THE LOW ALTITUDE THUMB RULE.
3. MAXIMUM RANGE BOUNDARIES ARE AERODYNAMIC ENVELOPES AND THE EFFECTS OF IR SHADING AS THE TARGET CONTINUES ITS TURN IS NOT CONSIDERED.

CO-ALTITUDE – 40,000 FEET
CO-SPEED – 1.0 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED



LEGEND
——— R_{MIN}
····· NON-MANEUVERING R_{MAX}
–·–·– 3G MANEUVERING R_{MAX}
– – – – 5G MANEUVERING R_{MAX}

CO-ALTITUDE – 40,000 FEET
CO-SPEED – 1.2 MACH
TARGET MANEUVER – INSTANTANEOUS HORIZONTAL RIGHT TURN, CONSTANT G AND AIRSPEED



CONFIDENTIAL

FDB-1T-(78-5)

Figure 1-68 (C) (Sheet 5 of 5)

PART 4 ESCORT

(U) The information contained in Strike Force Protection Tactics cannot cover all possible tactical situations; however, it does provide flight leaders with basic data to formulate their plans as a situation dictates.

STRIKE FORCE PROTECTION TACTICS

(U) GENERAL

(C) The mission of the F-4 while protecting a strike force is to provide air cover in order to prevent enemy fighter penetration of the main strike. If the strike is forced to drop its ordnance away from the intended target the enemy has accomplished its mission. Successful protection of the strike force is to be provided during withdrawal from the target area. Protection of the strike force may be provided in basically two methods:

a. BARCAP - Fighters placed in an area located between the strike force and the anticipated air opposition.
b. TARCAP - Fighters in direct support of and in the same general formation as the strike force.

(C) A minimum of four fighters should be utilized on either of these methods. In high threat areas, if sufficient assets are available, both TARCAP and BARCAP should be employed to gain the advantage of each method. Each methods execution, advantages, and disadvantages are discussed in the following paragraphs.

(U) BARCAP

(C) The number of aircraft employed by the BARCAP will depend primarily upon the number of the expected opposition but should be at least four aircraft in high threat areas. The fighters will position themselves between the force to be protected and the area of anticipated threat. This may be a stationary position or a moving one depending upon the movement of the force being protected. It will generally be stationary. The distance from the force will be dependent upon, but not limited to:

a. Type of expected threat
b. Topography
c. Weather
d. AAA/SAM
e. GCI availability

(C) Combat spread formation should be maintained for patrolling. The basic maneuvering utilized by the fighter should be loose deuce. The relative spread between elements will vary and be determined by the area to cover and number of fighters in the BARCAP. In general, the patrol should be executed in loose deuce sections in such a manner as to provide mutual internal support within each section and a quick response time to aid other sections if under attack by a superior number of enemy aircraft. CAP patterns and maneuvering should be chosen to optimize visual and radar coverage of the anticipated threat area.

(C) Advantages of BARCAP

a. Not restricted to the movement of the strike force. In general, area and altitude of the engagement is chosen by the friendly fighters.
b. Ability to operate at an airspeed at which both search and engagement capability are optimized.
c. Optimum search, patrol, or combat formations and pattern.
d. Minimum number of friendly aircraft to retain in visual contact.

(C) Disadvantages of BARCAP

a. Possibility of missed detection, and by so doing, leave the strike force open to attack. This is the primary reason for employing both methods of strike force protection if at all possible.

(U) TARCAP

(C) The number of aircraft employed by a TARCAP is dependent upon the size of the strike force and the anticipated number of aircraft in the enemy threat. It is recommended that no fewer than four aircraft be used in high threat areas. Presently, the primary enemy offensive air-to-air weapons are designed to be utilized within a 45° cone between 1/2 and 3 miles aft of the target. For these reasons the TARCAP must position itself to effectively counter this threat. Refer to figure 1-69 as a reference for the following discussion. Zone of responsibility and maneuvering area is divided by a line directly aft of the strike force. Each section then becomes generally responsible for and is free to maneuver within their zone. Step-up or step-down is left to air wing discretion but it is generally recommended that both sections operate 200-400 feet stepped up on the strike force. If the strike force is able to maintain sufficient airspeed (400-450 KCAS), then each section should remain relatively stationary in the 30° - 45° cone at 3 miles distance from the strike force. While it is understood that 3 miles is considered, at first, a large distance aft, any closer positioning will not allow an attack on the attacking enemy fighters. The one compromise is reduced forward lockout doctrine. The strike force must be briefed to aid in this respect.

STRIKE FORCE TACTICAL FORMATIONS

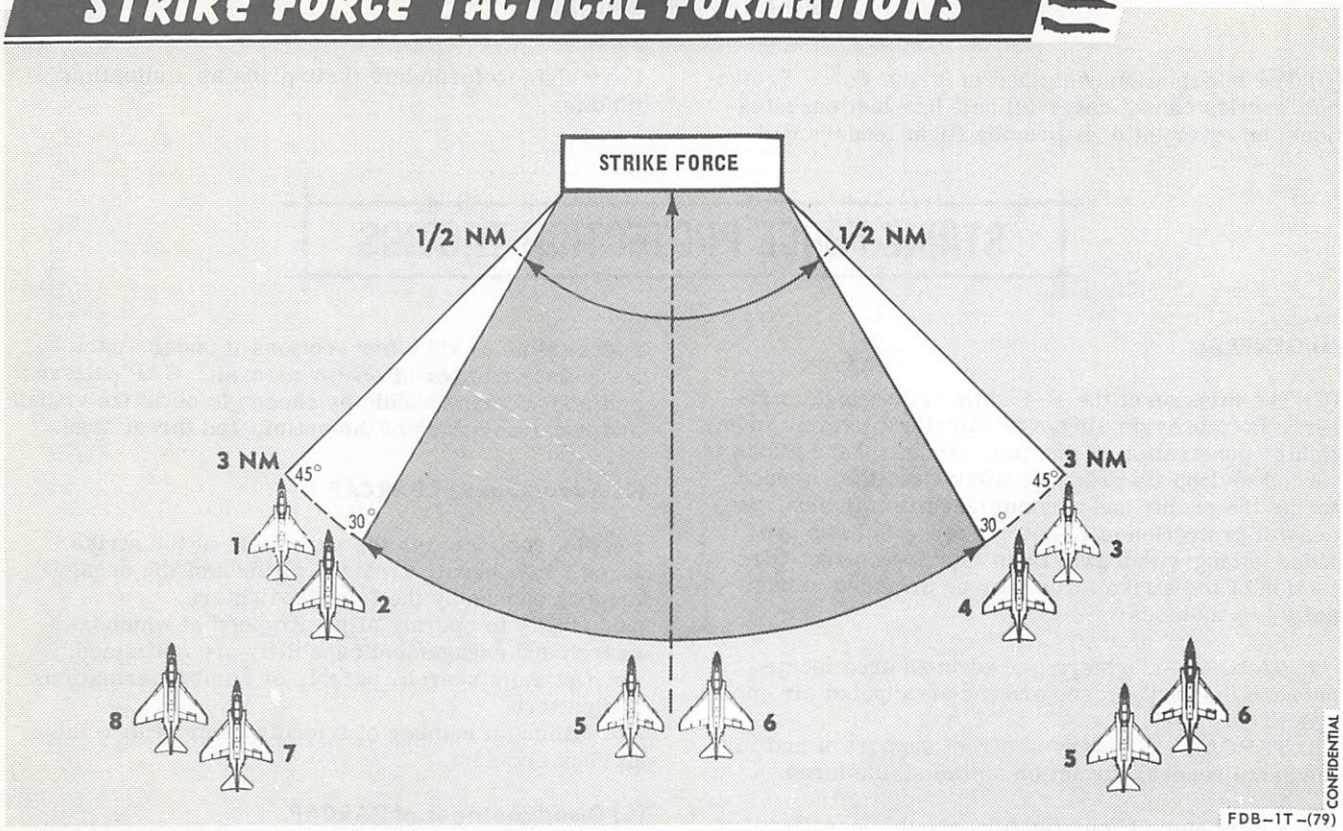


Figure 1-69 (C)

(C)
If the strike force is slow speed (A-4/A-7, 300-350 KCAS) the fighters are free to maneuver within their zone of responsibility aft of the 3-mile circle to maintain any desired airspeed. It is suggested that the fighters remain co-speed in the 30° - 45° cone until entering the anticipated threat area, then accelerate to maneuvering airspeed. Positioning of additional fighters is left to the discretion of the strike force commander. Suggested dispositions are:

a. Six fighters - one through four as before, five and six 3 - 4 miles aft of the strike force and required only to keep one through four in sight. Stepped up or down on the strike force as desired; suggested stepped down.
b. Eight fighters - one through four as before, five and six, seven and eight placed in a combat spread relative to the lead fighter sections in their zone. Visual responsibility is only to the fighter section they are covering. In essence, they are cover for the TARCAP.

(C) Any further fighters are unweildy and should be used as BARCAP or in a fighter sweep. All distances in the foregoing discussion are based upon the ability of the initial two fighter sections to retain visual contact with the strike force. The distances must be reduced if visual contact cannot be retained. However, make every attempt not to compromise your counter-threat capability. A fighter within a 1-mile distance of the strike force is of little value.

(C) Advantages of TARCAP

a. Close-in protection of the strike force.
b. Protection over the target area and during withdrawal.
c. Large psychological lift for the strike force.
d. Psychological deterrant to the enemy fighters.

(C) Disadvantages of TARCAP

a. Reduced lookout doctrine, both by reason of number of aircraft and distances involved.
b. A relative lack of maneuvering freedom.
c. A compromise of radar coverage due to generally always being oriented along the strike force axis and not the threat axis.
d. Restricted to the movement of the strike force.
e. Increased number of aircraft in the strike force, reducing strike force mobility and communication efficiency.

(U) SUMMARY

(C) In summary, it can only be stated that by far the best means of strike force protection is a combination of both TARCAP and BARCAP. The best aspects of both teams may then be utilized to provide maximum probability that they accomplish their mission; i.e., see that the bombers get their ordnance on the target. Why go twice if, by planning ahead, we can do the job properly the first time.

PART 5 COMBAT AIR PATROL

(U) This part contains Combat Air Patrol information and presents recommended briefing requirements, procedures enroute to, and on the CAP station, standard CAP patterns, and specialized CAP patterns.

BRIEFING REQUIREMENTS

(U) Effective employment of the CAP depends upon comprehensive briefings which include, as a minimum, the following:

a. Weather and Associated Effects.

(1) Weather in Task Group operating areas.
(2) Weather at CAP station, possible combat intercept areas, and divert fields.
(3) Wind conditions at altitude.
(4) Sea state.
(5) Ducting levels
(6) Contrail levels
(7) Ambient temperature vs altitude.

b. Task Group Operational Considerations.

(1) Probable early warning ranges and height finding capabilities in all sections and all altitudes.
(2) Surface-to-air missile (SAM) zone limits (friendly and enemy)
(3) Fighter exclusion zone limits
(4) Task Force/Group formations and dispositions
(5) Position of carriers in Group for each formation.
(6) Point of intended movement (PIM) variations
(7) Control of electromagnetic radiation (EMCON)
(8) Specific identification (ID) policy regarding Electronic ID - Identification, friend or foe (IFF), passive receiver analysis, etc.
(9) Air control assignment
(10) Communication frequencies and calls
(11) Authentication procedures
(12) Navigation air guard ships (positions and operating times)
(13) Selective identification, friend or foe (SIF) code messages for radio failure and communications ECM

c. CAP Station Assignment

(1) Sector or loiter pattern
(2) CAP relief point
(3) Policy for major weapon system deficiencies
(4) Search responsibility in CAP loiter pattern
(5) Combat fuel allowance (total fuel for intercepts)
(6) Cycle time (time from catapult to arrestment)
(7) Friendly field availability and location
(8) Ready deck information
(9) Airborne tanker provisions
(10) Emergency ejection instructions

d. Intelligence Information.

(1) Likely direction of raid approach
(2) Types to be expected and relative numbers of each type
(3) Altitude/Mach number and pertinent performance data typical of each type.
(4) Typical formation expected (close, stream, or wide, etc.)
(5) Identify features of each type
(6) Armament of each type
(7) Weapons loading typical of each type (bomb trajectory of stand off)
(8) Bomb release line for typical weapons
(9) Radar reflective area of each type
(10) IR detection range for each type
(11) Typical defensive and offensive tactics
(12) ECM capabilities of each type

e. Search and Rescue Information

(1) Disposition of SAR forces
(2) SAR frequencies
(3) SAR capabilities
(4) Safe areas
(5) Escape and evasion information.

PROCEDURES

(U) Under most conditions a military power climb should be used enroute to the CAP station. The military power climb allows for timely CAP relief and affords maximum fuel after reaching the station. The maximum on station time will be obtained by climbing straight ahead without turns. Excess turns, depending on where they are made in the climb, may shorten on station time as much as 5 to 10 minutes. If the CAP is assigned a low-far or long-range station, the run-out profile selected should be the best compromise between time enroute and cycle time. The pilot should adhere to the recommended climb schedule. If a turn has to be made before reaching CAP altitude, less fuel will be wasted if it is accomplished just after launch at moderate power or later at very shallow angles of bank. Low altitude rendezvous and section climb-out cost heavy in fuel and should be avoided if possible. The weapon system

should be checked soon after launch. Normally CAP relief can only be considered complete when on station with the airplane and the weapon system checked out satisfactorily. Once CAP airspeed and altitude are established, endurance is of major importance. A prime consideration is the angle of bank used in maintaining CAP station. Reduced fuel consumption is obtained by flying the aircraft near the minimum thrust required airspeed using low bank angle turns. When an airplane is banked, its load factor and apparent gross weight increase. In order to maintain balanced flight, angle of attack or airspeed must be increased. Either action results in drag increases, which require more thrust and fuel. The normal reaction is to add an increment of the maximum economy speed to permit turns without entering the back side of the drag curve. The greater the increment selected, the higher the excess fuel flow. If low bank angles are used, this added speed increment can be reduced. However, when the airplane is flown at maximum endurance airspeed, rough bank and altitude control can easily result in entry into the high drag region. The fuel consumed in accelerating back to loiter speed may equal or exceed the original fuel saved. Therefore, a minimum-fuel loiter pattern must be flown with extreme precision. Obviously, the selection of a higher than maximum economy loiter speed is justified if the CAP is stationed in an exposed area where it might be attacked. In this case, the loiter speed selected should allow for tactical maneuvering.

Note

- If the CAP pattern or area is limited such that it requires bank angles in excess of 15 degrees and a reasonable chance exists of being vectored for a bogey, maximum range cruise airspeed is recommended.
- EMCON conditions and ordnance proximity may modify radar operating procedures.

CAP PATTERNS

(U) GENERAL

(C) The presence of any type of enemy threat (AAA/SAM/MIG) necessitates that the CAP mission not be flown in a repetitive pattern. Although three basic patterns are given below, do not fly any of them in a predictable manner.

(U) OVAL CAP

(C) The oval CAP pattern is best from an endurance standpoint since turning flight is at a minimum. It should be oriented parallel to the direction of the expected threat. At mid and low levels it may be advantageously employed using vertical in place turns to reduce the time in turning flight.

(U) FIGURE EIGHT CAP

(C) The figure eight CAP pattern allows the pilot a turn of less than 135° for bogey vector from any point in the pattern. It costs more fuel than does the oval pattern because of the added time in turning flight.

(U) RECTANGULAR CAP

(C) The rectangular CAP pattern is similar to the oval except that a wings level cross leg is flown at each end of the pattern. It is generally used at night and in weather when the CAP section is flying in radar trail.

SPECIALIZED CAP

(U) MIG CAP

(C) MIG CAP is the utilization of a minimum of two fighters, and preferably more, for the sole purpose of searching out, engaging, and destroying enemy aircraft. They are not normally restricted to any area or force and have no protective mission other than each other. They will maneuver at all times in the threat areas as directed by the flight leader to achieve maximum offensive capability. The MIG CAP should attempt to utilize friendly radar control/electronic information, whenever possible, to ensure maximum effectiveness. The MIG CAP has one sole mission: seek and destroy enemy aircraft.

(U) FORCE CAP

(C) FORCAP may be defined as a specialized BARCAP. FORCAP will consist of at least an element of fighters positioned on a specific bearing and distance from the force to provide protection for the friendly naval surface forces against enemy threat, both surface and airborne. The FORCAP will normally be in relatively close proximity to the force (less than 100 n.m.) but at the discretion of the commander and as the threat dictates, may be positioned at considerably greater distances. FORCAP will always be under positive control. This control may emanate from the main body of the force or may be from a control ship placed outside the main body. At times, it may even consist of airborne control. CAP patterns will be flown so as to optimize radar and visual coverage of the anticipated threat sector. Altitudes to be flown will be dictated by type threat, weather, distance from the force, etc.

(C) Combat spread will be the normal patrolling formation, with loose deuce tactics utilized in the

(C)
event of an air engagement. At night or during IFR conditions, the section maintains altitude separation and either a radar trail formation or an individual tactical pattern relative to a preselected TACAN position.

(U) MISSILE CAP

(C) MISCAP provides specialized defensive protection against enemy anti-ship missiles and surface launch vessels which are potentially hostile to the friendly naval surface force. MISCAP aircraft positioning is oriented relative to the enemy missile threat axis and at a predetermined position to optimize the fighter weapon system to be employed against the threat. Primary consideration in fighter positioning must be the ability to detect and react against the threat in minimum time. MISCAP patterns will also be flown so as to optimize visual coverage during VFR conditions and radar coverage during night and/or IFR conditions. The anti-ship missile flight path between the enemy surface launch vessels and the friendly force will be known. This path can be readily plotted because the ASM is nonmaneuvering with a preplanned flight profile. AEW control will be used during IFR conditions to continually update the MISCAP on the projected threat axis which will be constantly changing due to the maneuvering of both surface forces. Disposition of fighter aircraft will be dependent on the number of potentially hostile surface launch vessels, the total number of ASM's they can effectively launch, and the number of MISCAP aircraft available. MISCAP aircraft normally fly on opposite ends of the desired CAP pattern to allow at least one aircraft adequate visual or radar coverage of the enemy launch platform and projected threat ASM axis at all times.

PART 6 INTERCEPT

(C) This part discusses in detail the operation of the weapon system in air-to-air intercepts, with recommended techniques to achieve maximum system performance. The tactics and intercept geometry are based upon expected missile performance against anticipated threat targets. For purposes of this manual, intercept control has been divided into two phases; the initial vectoring or approach phase under the control of an Air Intercept Controller (AIC), and the attack or terminal phase, under control of the aircrew. The approach phase terminates and the attack phase begins when the aircrew assumes control of the intercept (JUDY). Air intercept control procedures for the approach phase, including interceptor self-control are discussed in section III, part 1. The attack phase consists of the final attack procedures against various threats. The decision to employ combat air patrol (CAP) or deck launched interceptor (DLI) has been made and the interceptor has been initially vectored toward the target (approach phase). The tactics discussed are designed to optimize employment of the F-4/AIM-7/AIM-9 weapon system against targets in the low, medium, and high altitude environments.

CLASSIC ONE-ON-ONE INTERCEPT MANEUVERS

(U) GENERAL

(U) Basic intercept tactics are best understood by first examining classic one versus one intercept geometry.

(C) TERMINOLOGY

a. Aspect - Aspect is defined as the angle between the bogey's flight path and the LOS to the interceptor (figure 1-70). Aspect angle can quickly be computed by measuring the degrees and direction from the bogey's reciprocal to the magnetic bearing. For example, the aspect angle for a bogey tracking 040° bearing 250° from the fighter would be 30° right. Using the preceding procedure, the aircrew utilizes GCI or scope/compass information to measure the angle opposite and equal to the aspect angle (figure 1-70).

b. Magnetic Bearing - The magnetic LOS from the fighter to the bogey. Aircrew/GCI communication is facilitated through the use of magnetic bearing. Use of angle off requires heading update and bearing conversion by the controller.

c. Collision - A course that will maintain a constant bearing and decreasing range.

d. Conversion - Maneuvering that will increase or decrease existing lateral separation.

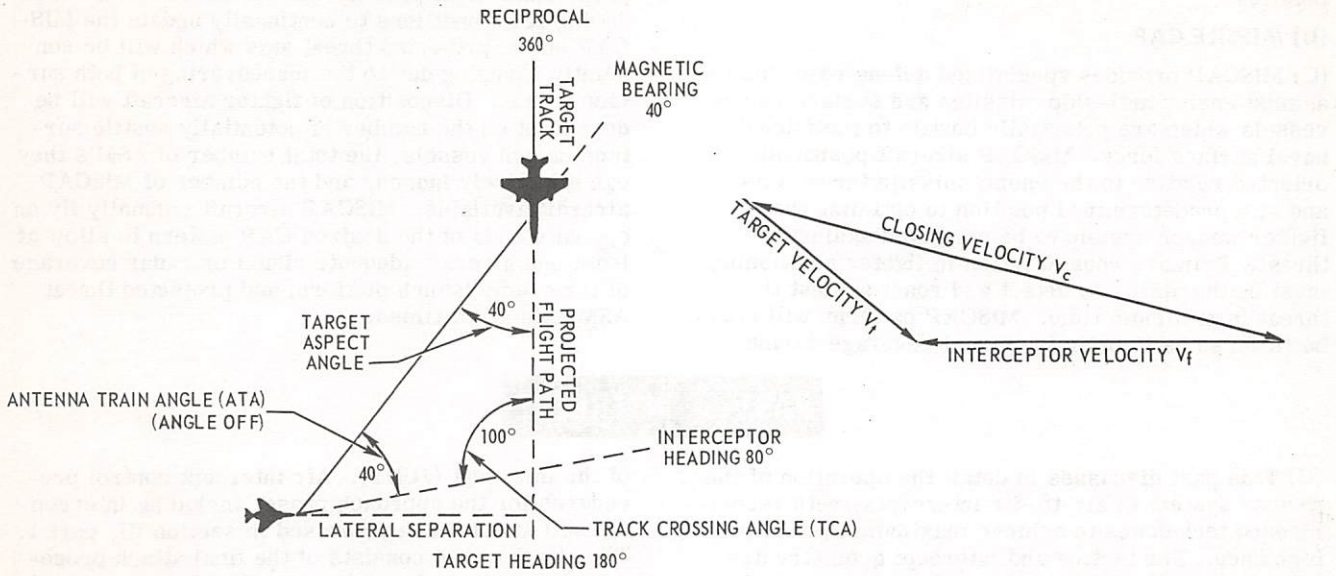
e. Lateral Separation - The distance between the fighter and the bogey's projected flight path (figure 1-70). Since the RIO has only slant range and aspect angle data, lateral separation must be indirectly computed. A more practical approach is to use aspect versus range check points such as those depicted in the pursuit intercept (figure 1-71).

f. Lag Pursuit - A curvilinear flight path flown with the fighter holding a heading which lags the line of sight to the bogey.

g. Lead Collision - A straight line course that points the fighter at the projected impact point for the bogey and the air launched weapon. This course actually lags the aircraft to aircraft collision solution. This is due to the higher relative velocity and attendant lower lead requirements of air-to-air missiles.

h. Lead Pursuit - A curvilinear flight path in which the fighter heading leads the line of sight. This is the final steering phase computed by both the AN/AWG-10 and the AERO-1A. A lead pursuit course allows multiple launch points as opposed to the singular launch position provided by a lead collision

INTERCEPT TERMINOLOGY



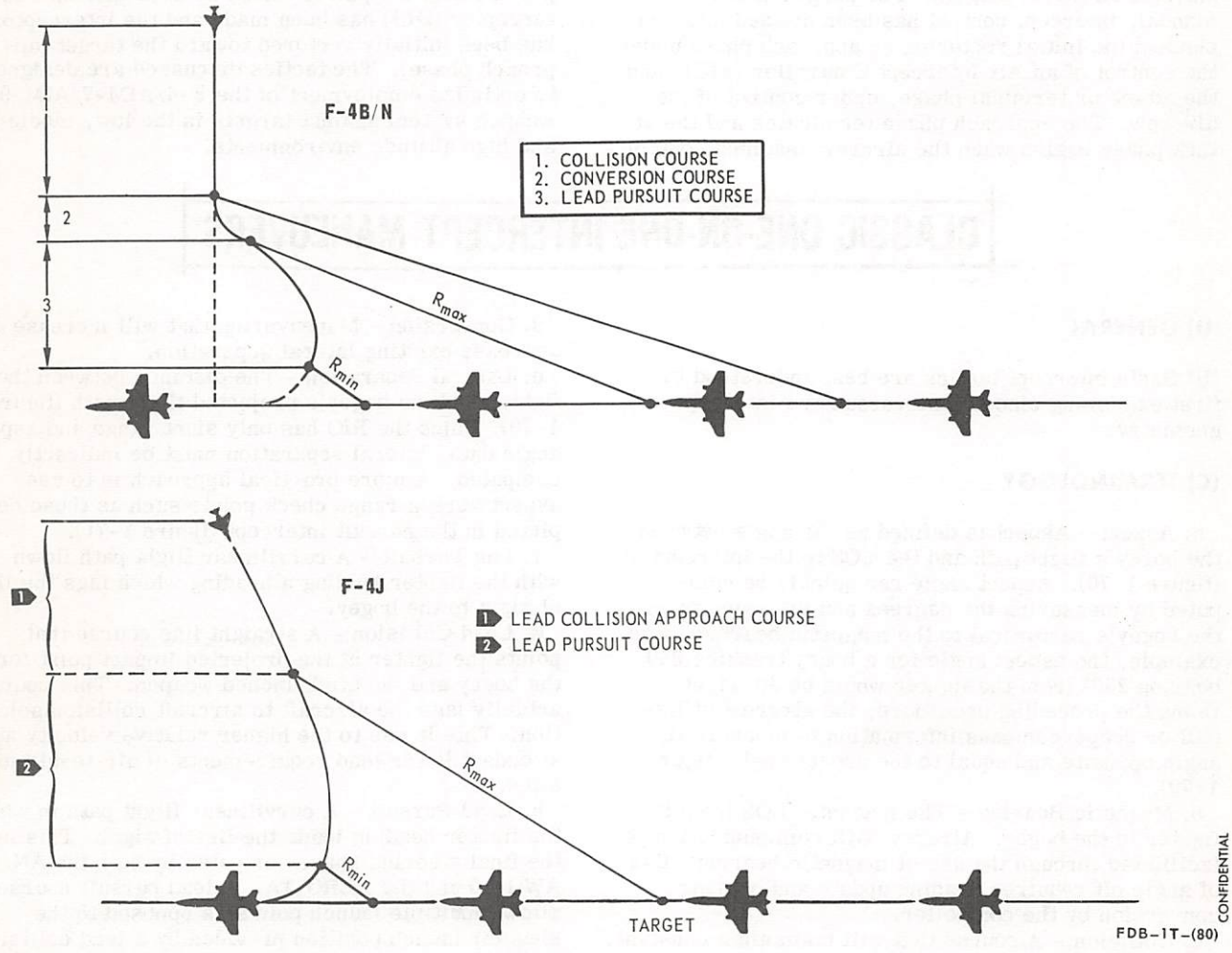


Figure 1-70 (C)

STERN CONVERSION (PURSUIT) CHECKPOINTS

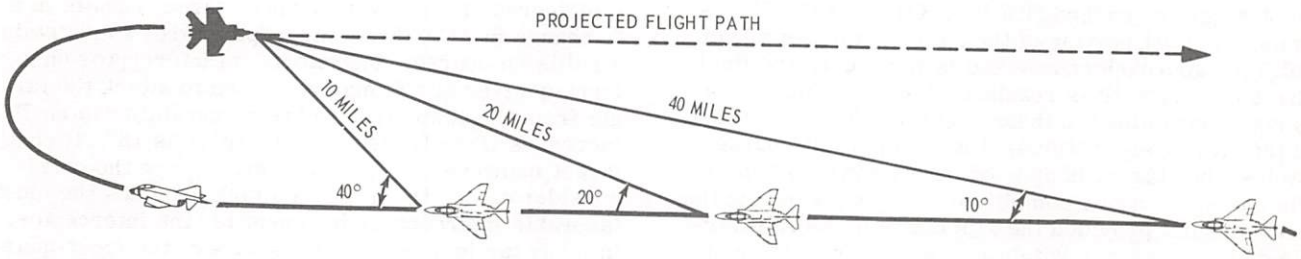


Figure 1-71 (C)

(C)
solution. A lead pursuit course will decrease degrees to go and closure rate and will increase aspect against a fixed heading/speed bogey.

i. Pursuit - A course which points the fighters flight path directly at the bogey. Pure pursuit is computed by the aim dot in the VI mode of operation (AN/AWG-10). Pursuit may also be defined as a course that points the ADL directly at the bogey. This course is computed in the HEAT mode of operation.

(U) MANEUVERS

(U) Stern Conversion (Pursuit)

(C) The stern conversion is utilized for night or all-weather stern attacks and can be employed for tanker rendezvous. The F-4 will arrive dead astern at 1 to 2 miles and will have AIM-7 or AIM-9 options available. The fighter should maneuver to attain 6 to 7 miles of lateral separation. Although the turn to bogey heading can be made with less separation, greater control is achieved by utilizing approximately 40,000 feet of lateral separation particularly in adverse weather. The following check points are employed:

(1) 10° aspect at 40 miles.
(2) 20° aspect at 20 miles.
(3) 40° aspect at 10 miles.

(C) At 10 miles the bogey is brought to the nose and held with lead or lag to attain the desired roll out range. If aspect is greater than desired, a turn to collision should be employed to maintain aspect and closure rate until arrival at one of the check points.

ATTACK PHASE

(U) INTERCEPT GEOMETRY

(C) On AN/APQ-72 systems, the fire control computer programs a pure collision course for an AIM-7 attack when the target is at long range to minimize time to intercept. The computer automatically programs the conversion course when a given line-of-sight range is reached (1.6 R_a). On AN/APG-59 systems, the first portion of the AIM-7 attack is a lead collision approach course and is flown until the final phase of the attack is reached. A conversion course is not programmed in these systems. The final phase of the attack (all systems), the lead pursuit course, begins when target is approximately equal to 1.05 R_a. The missile may be committed at any time during the lead pursuit, provided the aim dot is in the ASE circle and the target is within range. During AIM-9 attacks, the computer functions are reduced. The AIM-9 missile requires that the interceptor fly a pure pursuit course whereby the pilot keeps the target boresighted. This makes the steering information supplied to the aim dot a function of antenna position only. To understand the logic of the computer mechanization, a knowledge of intercept geometry is necessary. Figure 1-72 illustrates the different angles which can vary with the type of intercept.

(U) PREPLANNED ATTACKS

(C) The optimum employment of the weapon system is realized in preplanned intercepts which permit forward or rear hemisphere approaches to head-on or rear-quarter attacks. Preplanned intercepts, under the direction of an air intercept controller, offer significant advantages over unplanned approaches. The determining factors in selecting preplanned approaches are raid detection range and relative interceptor/target position. With sufficient time available, the interceptor can be vectored on a forward hemisphere approach to a head-on attack, or on a rear-quarter attack. Generally, the sequence of events in a preplanned attack are as follows:

a. Controller vectoring (approach phase).
b. Analysis of the tactical situation.
c. Target detection (attack phase).
d. Determination of terrain or surface features and target altitude.
e. Determination of target ECM/IRCM capability.
f. Determination of optimum weapon selection.
g. Launch mode.
h. Missile launch.
i. Reattack.

(U) FORWARD HEMISPHERE ATTACKS

(C) As described in section III, part 1, the air intercept controller will attempt to vector the interceptor in a forward hemisphere approach to the target. This approach results in a head-on or front-quarter attack. Attacks from the forward hemisphere will result in successful intercepts under a variety of tactical situations. In the case of a co-speed target, a front-quarter attack can result from a forward hemisphere or beam approach. However, consideration of closing velocity, target size (radar cross-section), altitude above surface clutter, ECM, target maneuvering and their effect on the radar and the AIM-7 missile limit the choice of operational suitable track crossing angles. Target maneuvering, ECM, target size, and environmental clutter considerations reduce the range of favorable track crossing angles. One degree of turn by a co-speed target results in a 2° change in TCA if the interceptor turns to maintain a collision course. Therefore, an interceptor on a front-quarter attack may be forced to attack the target from the beam area where vulnerability to chaff increases if the target turns as little as 15°. If chaff, target maneuvering (jinking), and V_c are the only considerations, the head-on attack provides the most favorable intercept environment for the interceptor. In many tactical situations, however, the front-quarter attack allows less target penetration than the head-on attack, since for the head-on, the interceptor must be initially positioned directly ahead of the target to ensure a head-on attack at the time of missile launch. The front-quarter attack also allows less target penetration during the reattack maneuver than does the head-on. With respect to warhead lethality, studies have shown that the lethality of the AIM-7 fired from a front quarter attack is greater than that of one fired from a head-on attack. However, the head-on attack provides the AIM-7 with the best possible guidance and fuzing environment, especially when launched against small targets or in a heavy clutter environment, and results in smaller average miss distances than firing from the front-quarter attack. This factor partially compensates for the degradation in lethality attendant to a head-on firing and tends to produce similar single-shot kill probabilities in each case. In certain ECM environments, the front-quarter attack is superior to the head-on. Section I, part 8 of the Secret Supplement contains additional information on this condition.

Note

When target acquisition has been accomplished in pulse doppler, a rapid relock to pulse should be made as soon as a favorable pulse environment has been reached. It is recommended that this be accomplished prior to 20 miles to preclude the possibility of losing radar track in the final attack phase. Pulse gain should be optimized in the 25-mile range to facilitate the rapid relock. If during the rapid relock attempt the target is not visible in the B-sweep after switching to pulse mode, hold the action switch at Half-Action, return the mode selector to pulse doppler, realign the target in the velocity gate on the expanded velocity display, and initiate Full-Action for pulse doppler track until a more favorable pulse environment is reached. This procedure is not recommended for acquisition of small, low altitude targets where noise from sea return or terrain features severely degrades the pulse system to a point where acquisition is impossible.

INTERCEPT GEOMETRY

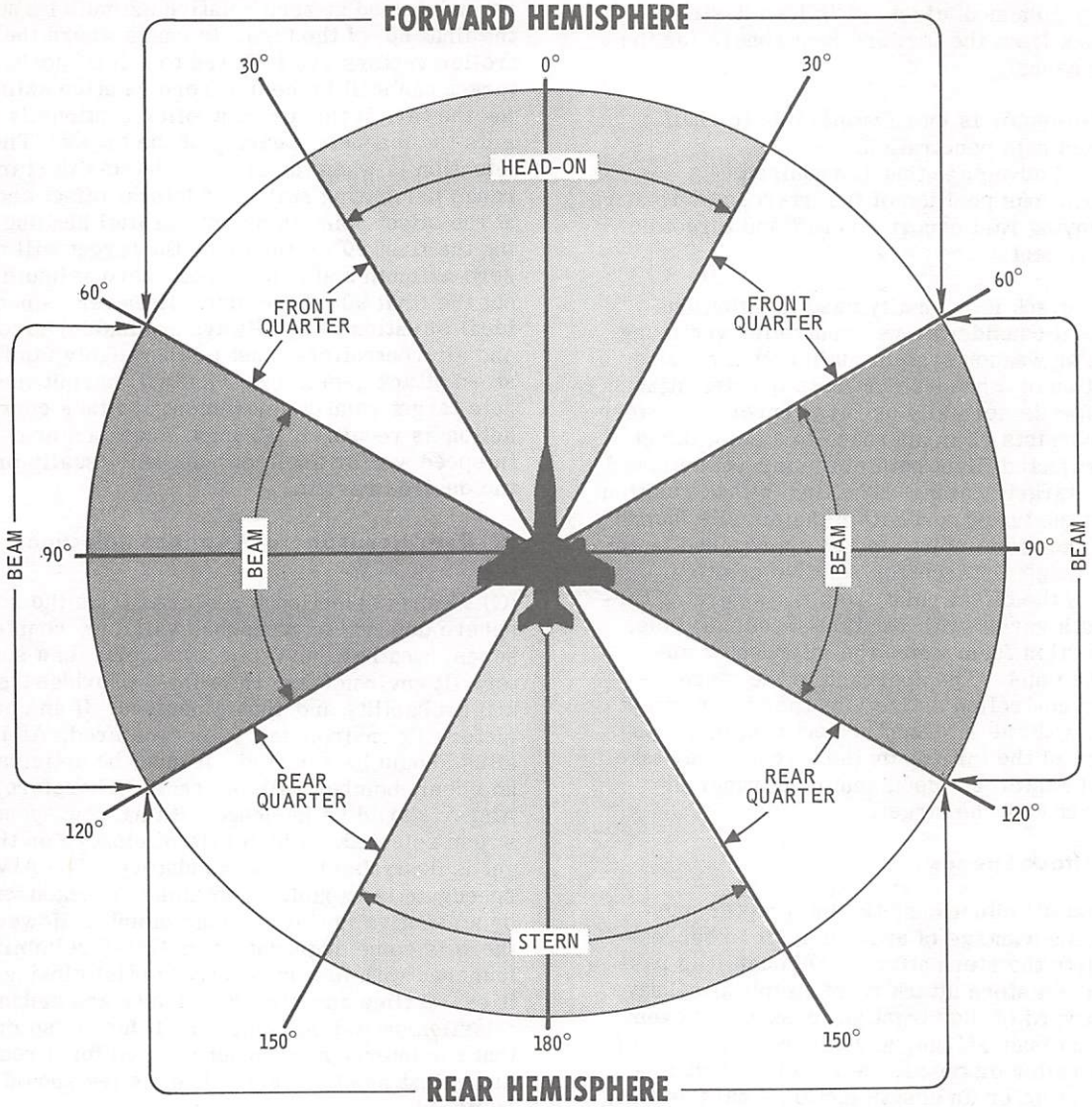


Figure 1-72 (C)

(U) Forward Hemisphere Attack Speeds

(C) Speeds used for attacks from the forward hemisphere depend upon target speed and altitude, allowable penetration, and interceptor fuel state. Under normal circumstances, the interceptor should strive for a 1.2:1 speed advantage over the target. If fuel state for the tactical situation dictates, this may be reduced to co-speed. Normally, the target should never be permitted a speed advantage over the interceptor.

(U) Forward Hemisphere Weapon Selection

(C) The AIM-7 missiles will be used during attack from the forward hemisphere. As a rule-of-thumb, two missiles should be fired during the attack. However, in a clear air mass, single missiles may be fired if sufficient time and fuel are available to assess the individual firings. If fuel for only one pass is available, all AIM-7 missiles should be fired.

(U) Forward Hemisphere Summary

(C) The optimum attack from a forward hemisphere approach is the head-on attack. If target penetration must be reduced, or in certain ECM environments, this may be modified to a front-quarter attack. The head-on attack optimizes good GCI/CCI control and is relatively immune to the effects of chaff. The ability to counter target jinking is optimized. Reattack capability is satisfactory for AIM-7 missiles.

(U) REAR HEMISPHERE ATTACKS

(C) The rear hemisphere approach results in either a stern or rear-quarter attack. Although the stern attack is a preplanned attack, it is less desirable than an attack from the forward hemisphere for the following reasons:

a. The interceptor is more vulnerable to chaff.
b. Increased raid penetration.
c. The speed advantage that is required.
d. The hazardous position of the interceptor relative to accompanying raid escort aircraft and target defensive armament.

(C) A stern attack is normally used in situations where tactical considerations, controller vectoring error, and/or weapon system malfunction preclude the completion of a head-on or front-quarter attack. A single offset is normally used to convert to a stern attack. It consists of an approach to a point offset from the projected flight path of the target, followed by a turn to target heading. The final attack position is astern of the target and within the missile launch envelope. The offset point may be approached from almost any target/interceptor relative position. Separation of the offset point from the projected target flight path varies with relative speed, altitude, and the direction from which the interceptor approaches the point. The approach to the stern attack may be controlled entirely by the air intercept controller, with the interceptor vectored into a position astern of the target, or the aircrew may take control of the intercept upon achieving radar or visual contact with the target.

(U) Stern Attack Speeds

(C) In almost all situations, the interceptor must have a speed advantage of at least 1.2:1 to successfully complete the stern attack. Although it is possible to make a stern attack from an initial relative position forward of the target at co-speed or even with a speed disadvantage, any error on the part of the air controller or the aircrew could result in a missed intercept or an unsatisfactory final position, requiring a prolonged tail chase. A speed advantage is desirable in order to launch either the AIM-7 or AIM-9 missile from the stern area. Caution should be exercised if speed is reduced and lockon is accomplished within the missile launch envelope. It is possible to back out of the missile launch envelope and still retain an in-range indication. When the target is detected and the intercept is assured, speed should be increased to decrease raid penetration and to increase R_{max}. The missiles may then be launched either visually or on radar information. When the initial position of the interceptor is aft of the target's beam, the highest practicable speed should be used to close on the target.

(U) Maneuvering Considerations

(C) There are no set rules for the angle of bank to be used in the final turn to target heading from an offset point forward of the target's beam. Generally, however, regardless of whether the attack is controlled by the air intercept controller or the aircrew, sufficient lateral separation should be attained so that a 30° banked turn can be made. If the target has been detected on radar, the aircrew should increase or decrease the angle of bank so that the target will be maintained at zero relative azimuth throughout the final 60° of the turn. In cases where the air controller vectors are followed to a final position, the target can still be held at zero relative azimuth during the turn if the air controller continually transmits the magnetic bearing of the target. The ideal situation is when the aircrew detects the target at a range permitting sufficient lateral offset and arrival at the offset point on an antiparallel heading. During the first 90° of the turn, the target will drift to zero azimuth and remain near zero azimuth throughout the final 90° of the turn. However, since the ideal situation is not always attainable, aircrews and air controllers must be thoroughly familiar with stern attack geometry. This will permit them to note target relative movement and take corrective action as required. Prompt increases or decreases in speed and/or angle of bank will usually produce the desired results.

(U) Rear Hemisphere Weapons Selection

(C) Weapon selection for attacks from the rear hemisphere depends on weapons available, countermeasures, weather, and time available. In a satisfactory IR environment, the AIM-9 provides the greatest kill probability and should be used. If an unsatisfactory IR environment is encountered, AIM-7 missiles should be selected. It must be anticipated that an enemy bomber will use chaff. Therefore, the AIM-7 should be launched with narrow speedgate sweep selected. A high rate of closure on the target is desirable but not mandatory. The AIM-7 speedgate is capable of obtaining a lockon with zero or a negative initial closing velocity. However, there is some degradation in AIM-7 reliability when launched with low or negative initial closing velocities. If time and closing velocity are critical, two missiles should be launched. If fuel is so critical that the interceptor cannot be used for a reattack or against another raid, all missiles should be launched.

(U) BEAM ATTACKS

(C) Since beam approaches often terminate in undesirable attack aspects, the aircrew should endeavor to convert the intercept to a front-quarter or stern attack. Use of the B-sweep for establishing a collision course and converting to aim dot steering prior to R_{max} will result in the best possible beam attack but not necessarily the best missile launch environment.

(U) Establishing a Collision Course

(C) In the AN/APQ-72, a noisy aim dot (erratic) may cause difficulty in determining whether the interceptor is on a collision course at long ranges. In the AN/APG-59, centering the aim dot establishes a lead collision course and does not indicate a collision course. Under these conditions, the B-sweep

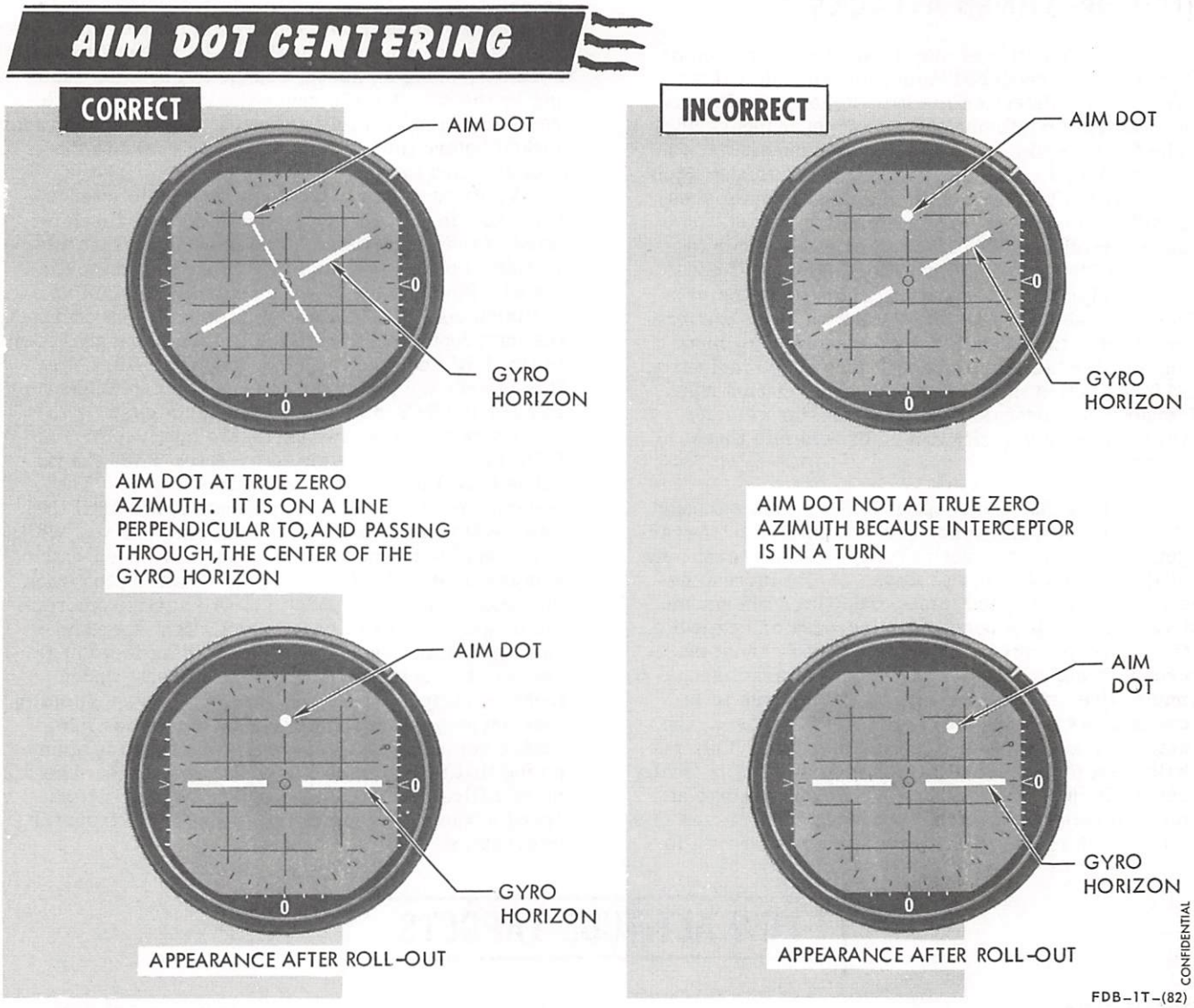


Figure 1-73 (C)

(C)
should be used to verify the course of the bogey. If the B-sweep remains at a constant azimuth, a collision course is established. If the B-sweep is drifting in azimuth, the interceptor must be maneuvered so that the B-sweep remains at a constant azimuth. In the F-4J, this means turning away from the B-sweep if the aim dot is centered.

(U) Aim Dot Centering

(C) The aim dot is not space stabilized. Therefore, if large angles of bank are used or if there is a large interceptor/target altitude differential, the aim dot should be positioned relative to the gyro horizon rather than the scope center (figure 1-73). If the RIO prefers, he may use the B-sweep position (which is stabilized) during these turns. In the heat mode (increased aim dot sensitivity), the target should be centered in azimuth, leaving only a pitch correction to center the dot.

(U) Converting to the Stern Attack

(C) As previously stated, the most desirable attack is the head on or front-quarter attack. However, in situations where the air controller is using collision vectoring to a beam approach, attacks from the forward hemisphere are not always possible. In some cases, the choice must be made between a beam or stern attack. Unless the urgency of the situation demands an immediate attack without regard to other considerations, the stern attack should be selected. Beam approaches may be easily converted to stern attacks by establishing a collision course and turning toward the target at a predetermined offset point. Reversing the turn as the target drifts toward zero azimuth will then place the interceptor in the stern area. When the intercept starts from a position on or behind the target beam, the interceptor is committed to a stern attack unless sufficient speed is available and the tactical situation permits conversion to the forward hemisphere.

(U) UNPLANNED ATTACKS

(C) Unplanned attacks may result from: radom detection of unannounced raids; low altitude raids where early detection is difficult; lack of adequate air controller information; or target maneuvering. The first step in completing an unplanned attack is to establish a collision course with the target. Stopping any drift of the target in azimuth establishes a collision course. Once a collision course has been established, the aircrew must endeavor to complete the intercept expeditiously and, if possible, improve the intercept geometry in the process. If the air controller cannot supply sufficient or reliable target information, the aircrew must analyze the tactical situation. One scope indication which supplies the aircrew with information concerning the tactical situation is closing velocity (V_c). Closing velocity can be broken into three categories:

a. V_c less than interceptor TAS. In this situation, the interceptor is in the rear hemisphere of the target. If the target is not in range, the intercept may still be completed in two ways: (1) By increasing the interceptor speed (fuel permitting), the antenna train angle will subsequently increase and expedite the intercept. (2) If interceptor speed cannot be increased, a slight turn away from the target should be made, thus causing the antenna train angle to increase. As the range to the target decreases, the antenna train angle will further increase. This results in a higher overtake when the aim dot is finally centered, just prior to R_{max}. A high overtake at missile launch is desirable because it increases missile launch range, provides a more positive V_c for the AIM-7, and increases the defensive fire control problems of the target. It is recommended that normally the antenna train angle not be allowed to exceed 50°, since an abrupt change in speed or heading by the target could cause the radar antenna to reach the gimbal limits and subsequently break radar lockon before the aircrew is able to evaluate the situation and take corrective action.

b. V_c greater than, but less than double interceptor TAS. In this situation, the interceptor is forward of the target beam. The most important information to obtain is your position in relation to the target. Stopping the B-sweep drift will establish a collision course. To establish the collision course, the interceptor must continue to turn in the direction of the drift until the target no longer drifts. After this is accomplished, the interceptor can maneuver to alter the TCA as the situation dictates.

c. V_c greater than two times the interceptor TAS. If V_c is more than double interceptor TAS, the target is traveling faster than the interceptor. The recommended action is to increase speed until the interceptor speed is greater than one-half V_c. While it is possible to conduct a satisfactory speed-disadvantage intercept, it should only be attempted when fuel state makes it mandatory. A situation wherein the target appears to have only a slight speed advantage will not necessarily remain static. The target may be accelerating for a final dash. Under these conditions, what was formerly a poor situation may develop into a hopeless one, unless the interceptor commences acceleration immediately upon noting that the target has a speed advantage. The most difficult problem in handling a target with a speed advantage is its ability to jink away from the interceptor.

LOW ALTITUDE TARGETS

(U) GENERAL

(C) The limiting factor in successful attacks against low altitude targets is frequently the ability of the aircrew to obtain radar detection and lockon. Terrain masking, temperature gradient, atmospheric refractivity, target size, surface features, scope background clutter, and radar look-down angle are limiting variables in detection ranges. Radar detection is greatly improved if the interceptor can descend to co-altitude or below the target. The ability of the aircrew to detect a nonstationary target on the radar scope is one of the most important factors in low altitude detection. The AN/APG-59 radar pulse doppler mode possesses an increased look-down capability against very low altitude targets. Since full system launches (radar automatic track) optimize the weapon system capability, obtaining radar lockon is highly desirable.

(U) LOW ALTITUDE

NEW NEW

(C) Several factors must be considered in order to determine the optimum attack for an AIM-7 launch against low altitude targets. In an air defense role, whether defending a carrier task force or a landing field ashore, a head-on attack tends to minimize enemy penetration distances. In addition, the head-on attack optimizes both the primary mode (pulse doppler) of the AN/APG-59 radar and the guidance characteristics of the AIM-7E/-7E-2. In the pulse search modes, target V_c will be greater and target movement will be more discernible. If the interceptor is under positive GCI/CCI/ACI control, it is easier for the controller to maneuver the interceptor constantly toward the bogey's flight path than to properly position it for a stern attack. If the bogey is under GCI control, an interceptor turn for lateral displacement in a stern attack may provide the enemy controller an easy chance to turn the bogey away and prevent the engagement by creating a long range tail chase.

NEW NEW NEW NEW NEW NEW

(C) Beam attacks should be avoided. Missiles launched from a beam attack against low altitude targets have little chance of success.

(C) Stern attacks are necessary under several situations. First, if the interceptor radar will not permit narrow speedgate inputs to the AIM-7 missiles and operational AIM-9 missiles are aboard, then a stern

(C) attack is the optimum for the F-4. Secondly, if visual identification is required for clearance to fire and the bogeys are expected to be small, then a stern attack allows visual identification in the missile launch zone which may not be possible in the forward hemisphere.

(C) If the target altitude is suspected to below 5000 feet AGL and the interceptor is utilizing a pulse search mode with a search look-down angle of 5° or greater, side lobe search techniques should be employed (refer to figure 1-47). If the target is detected in this manner with the AN/APQ-72 radar or in a chirp mode with the AN/APG-59 radar, a decrease in the look-down angle is required to optimize both the radar track and AIM-7E/-7E-2 capabilities. To eliminate the look-down angle prior to reaching AIM-7E/-7E-2 mid range, establish an angle of descent in excess of twice the antenna look-down angle and gain a speed advantage. If the target is detected and tracked in the short pulse mode with the AN/APG-59 radar, acquisition and the probability of maintaining track are greatly increased as compared to the chirp mode. Great care must be taken in presetting the pulse gain for low altitude detection as well as positioning the interceptor at co-altitude or below if a relock from pulse doppler track to pulse track is anticipated. Low altitude radar techniques are covered in part 2, this section.

(C) With the AIM-7E/-7E-2, narrow speedgate launches are vital in the low altitude environment to prevent AGC action from reducing the target return in the speedgate noise bank. The launch should be made between mid range and R_{min}. Boresight launches are not recommended against low altitude targets. Narrow speedgate launches are not possible with the AN/APG-59 radar in manual track or boresight without lockon. When AN/APQ-72 radar lockons cannot be obtained, the AIM-7 may be launched with the narrow speedgate sweep selected in the boresight mode by using the target aspect switch to provide manual closing velocity.

(C) Even when radar lockon can be maintained with the interceptor above or co-altitude with the target, the AIM-7 success probability is optimized when the missile is launched with a look-up angle. Both speedgate lockon and fuzing reliability are increased. Refer to AIM-7 Low Altitude Capability in part 3, this section. If radar lockon cannot be maintained because of excessive noise from surface background clutter, an attempt should be made to maneuver the aircraft for a re-attack using the AIM-9 missile.

WARNING

Extreme caution should be exercised when intercepting low altitude targets in a high density surface-to-air threat environment.

(U) LOW ALTITUDE/HIGH VELOCITY TARGETS

(C) The low altitude/high velocity target is likely to have some or all four characteristics which make attacks by high performance jet aircraft with radar guided and infrared seeker missiles very difficult. These characteristics are:

a. Very fast flight (above 500 knots TAS).
b. Very low flight profile (below 1000 feet).
c. Very small radar reflectivity.
d. Minimum reaction time to effect an attack.

(C) Surface features (water and land) will further aggravate the problem by increasing background clutter making radar detection and lockon difficult. Certain atmospheric phenomena such as refractivity, trapping and ducting layers, tend to either increase or degrade radar system capabilities. Size and flight profile of these targets usually preclude a planned intercept attack phase. The characteristics of the low altitude/high velocity targets create a difficult enviornment for the weapon system. Because the success of the AIM-7 missile to guide against a low altitude target is dependent on its ability to overcome the effect of sea/ground clutter, the aircrew must assess the conditions of the surface features and adjust the missile launch range accordingly. In a heavy clutter environment, the AIM-7 maximum launch range must be reduced to give the missile its best chance to guide and fuze successfully. The AIM-7 should be launched from as near head-on and co-altitude as the intercept permits. The AIM-9 has an increased capability against this type target because of the associated IR emissions with higher power settings. Section V, part 2 of the Secret Supplement contains additional information on a low altitude antiship missile which is a characteristic target.

(U) LOW ALTITUDE/LOW VELOCITY TARGET

(C) The low altitude/low velocity target is likely to have some or all five characteristics which make it relatively invulnerable to high performance jet aircraft. These characteristics are:

a. Very slow flight (below 200 knots TAS).
b. Very low altitude (below 1000 feet).
c. Very maneuverable.
d. Very small radar reflectivity.
e. Very little IR emission.

(C) In addition, the type of background (water or land) will further aggravate the problem. Violent evasive maneuvers can be expected from these targets when encountered. They have extremely small turn radii and are capable of large changes of altitude in a relatively small airspace. These characteristics of the low altitude/low velocity targets cause the weapon system to be tactically marginal in most cases. As previously discussed, the successful guidance of the AIM-7 missile at low altitude is the ability to overcome the effects of sea/ground clutter. Since doppler separation is greatest with maximum or minimum closing velocity for a given interceptor speed, the AIM-7 should be launched from a head-on or stern attack with narrow speedgate sweep selected. The AIM-9 also has a limited capability against this type of target because of the low IR emission. Maximum missile detection range varies according to the size of the aircraft, engine throttle settings, and operating environment. An AIM-9 attack at co-altitude or

(C)
at a small diving angle will likely result in unacceptable detection ranges for missile firing. Therefore, a shallow climbing attack from a position 1000 to 2000 feet below the target is usually required.

(U) OPERATION AGAINST SURFACE TARGETS

(C) The F-4 AIM-7 weapons system does provide the Fleet with a quick reaction, all-weather defensive capability against enemy surface vessels. Surface targets in this discussion are defined as approximately 85 feet in length having at least a 100 square meter, all-aspect radar reflectivity and capable of speeds up to 45 knots. In any type of low altitude operation the detection capability of the radar depends upon sea state, atmospheric refractivity, altitude of the fighter, and target radar cross section. The AIM-7 guidance capability depends upon its ability to discriminate between the target return, MBC, and noise clutter. The most significant problem area of the AIM-7 missile in the air-to-surface environment is the possibility of premature fractional doppler fuzing (FDF) prior to target intercept, which is caused by a low signal-to-noise ratio preventing target discrimination from the background.

(U) Optimum Tactic

(C) The following tactic provides the optimum all-weather capability for the F-4 AIM-7 weapons system in an air-to-surface role. A search opportunity range of 25 NM is recommended for both the F-4B/N and F-4J at an approach altitude of 500 to 1000 feet MSL against 100 square meter radar reflective targets. Larger targets (DLG type, approximately 1000 square meters) permits acquisition at altitudes up to 3000 feet MSL due to the increased radar reflectivity enhancing radar and missile acquisition in the presence of clutter. If the position of the target is accurately known and the RIO has not acquired a lockon prior to 15 NM, the fighter should descend to 100-200 feet MSL in order to improve the opportunity for acquisition. The lower altitude reduces the radar look-down angle, which silhouettes the target above the ocean surface and reduces the effect of sea state clutter. After radar lockon the fighter should climb to an altitude 500 feet above the desired launch altitude (figure 1-74). Consideration should be given to the target surface-to-air defensive capabilities. The attack should be planned considering the available launch points depicted in figure 1-74 and the threat facing the fighter in order to reduce exposure time to a minimum. For example, if a launch range of 4.5 NM is selected at an approach speed of 0.5 IMN, then a pull-up should commence at 8 NM in order to reach 500 feet above the launch altitude. At 0.75 NM prior to the desired launch point, a dive equal to look-down angle of the radar should be commenced to center the aim dot at the launch point. A push over entry rather than a rolling entry should be used to reduce the possibility of losing radar automatic track by decreasing the radar gyro rate of change associated with aircraft maneuvers. The launch altitude should be attained at the desired slant range with the aim dot centered.

Note

AIM-7 firing limitations require at least 0.5 positive G at missile launch.

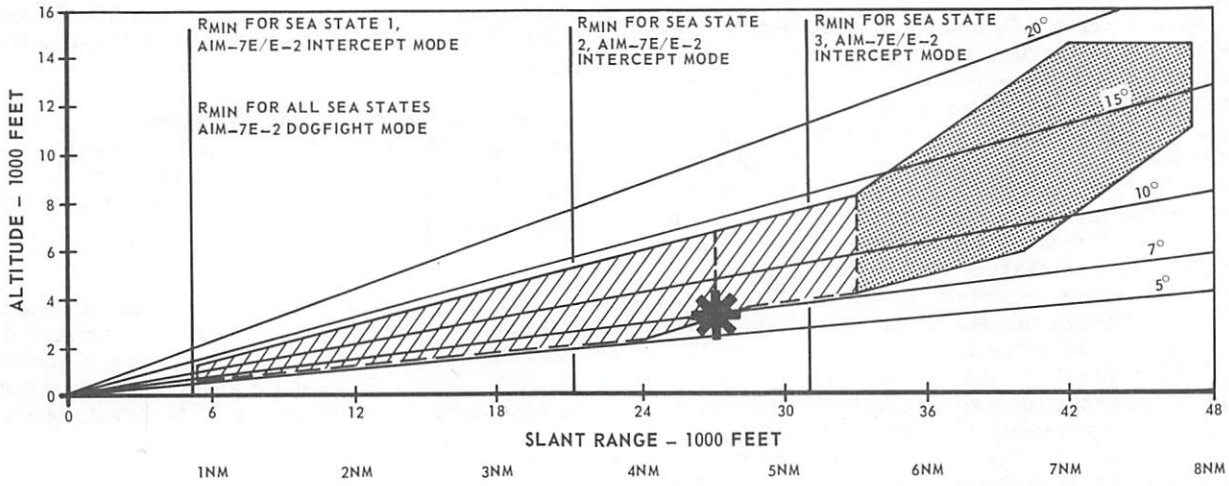
(C) After launch the pilot should place the pipper (set at 35 mils) on the target if weather and visibility permit in order to provide boresight guidance in the event of radar break-lock after launch. If the radar breaks lock, the RIO should switch immediately to BST on the radar set control panel or select Half or Full-Action on the antenna hand control and attempt to spotlight the target. A dive angle equal to the angle established at missile launch should be continued until missile intercept. If the launch range is decreased to 2 NM, target intercept should occur within 8 seconds. The fighter speed should be at least 0.5 Mach in order to minimize missile inflight drag at the time of launch. At speeds less than 0.5 Mach the missile achieves less velocity which decreases missile control performance and target damage at impact. Additionally, missile G bias problems increase the probability of premature missile impact with the water. A final consideration is the inadequate maneuvering speed afforded the fighter at speeds below 0.5 Mach.

Note

Due to present AIM-7E/E-2 fuze limitations, the maximum recommended firing range is 4.5 NM for the previously mentioned 100 square meter target. A possibility exists that maximum range of the AIM-7E/E-2 for a 1000 square meter target may be extended to the maximum aerodynamic range of 8 miles, but has not been tested at this time.

AIM-7E/E-2 AIR-TO-SURFACE LAUNCH ENVELOPE

100 SQ. METER TARGET



LAUNCH SPEED MUST BE IN EXCESS OF 0.5 MACH

LAUNCH SPEED MUST BE IN EXCESS OF 0.92 MACH

Notes

1. ✱ OPTIMUM LAUNCH RANGE AND ATTACK ANGLE CONSIDERING EFFECTS OF G BIAS AND FRACTIONAL DOPPLER FUZING.
2. THE LOWER BOUNDARY OF THE LAUNCH ENVELOPE IS DETERMINED BY THE EFFECTS OF THE MINIMUM MISSILE MANEUVERING AIRSPACE AND MISSILE G BIAS.
3. BECAUSE OF PREMATURE FRACTIONAL DOPPLER FUZING LIMITATIONS, DO NOT FIRE IN EXCESS OF 4.5 NAUTICAL MILES SLANT RANGE.

CONFIDENTIAL

FDB-IT-(239)

Figure 1-74 (C)

MEDIUM ALTITUDE SUBSONIC TARGETS

(U) GENERAL

(C) Medium altitude includes bomber cruising altitudes, level free-fall bombing release altitudes, and air-to-surface missile (ASM) launch altitudes. The performance data of potential bomber threats show that the medium altitude band normally extends from 15,000 feet to slightly over 40,000 feet. The speed range of these targets varies from 0.7 to 0.9 Mach. The primary medium altitude threat is the bomber carrying air-to-surface missiles. Normally, the interceptor aircrew will be unable to distinguish between bombers carrying air-to-surface missiles and those that are not carrying them. However, if it is known that a certain bomber is carrying an air-to-surface missile or has launched an ASM, the bomber should be considered the prime target, and should be destroyed as expeditiously as possible. Destruction of the bomber may neutralize the launched ASM if it requires radiation from the parent aircraft for initial guidance. Another characteristic of medium altitude targets is that they constitute the prime ECM threat. All medium altitude targets should be treated as an ECM threat and ECM tactics should be used at all times. Even though ECM is not encountered, lockon should be frequently broken and reacquired down to a range of approximately 15 miles. This allows the aircrew to assess the tactical situation, check for multiple targets, and check for the launch of an ASM.

(U) MEDIUM ALTITUDE TACTICS

(C) Use of the head-on or front-quarter attack against medium altitude subonsic targets provides the following advantages:

a. Best attack against targets employing countermeasures.
b. Best against target evasive maneuvering.
c. Best attack against an ASM.
d. Decreases effects of bomber defensive armament.
e. Minimizes raid penetration.
f. Optimum AIM-7 launch environment.
g. Provides satisfactory reattack due to interceptor performance at this altitude.

(C) The recommended final attack speed and altitude for a frontal attack on medium altitude targets are from 0.9 to 1.2 Mach and co-altitude. When ECM and target jinking are factors, the head-on attack should be used. To remain within the head-on aspect, interceptor bank angles in excess of the standard 30° bank may be necessary. The stern attack provides the following advantages against medium altitude targets:

a. Either AIM-7 or AIM-9 missiles may be launched.
b. It provides an excellent reattack and continuing attack capability.
c. It allows the aircrew to conduct visual intercepts under VFR conditions.
d. Target damage can often be assessed prior to committing subsequent missiles.

(C) If an accurate fix on the speed of the target is not available, an interceptor speed of 550 knots TAS will usually be satisfactory. However, a 1.2:1 speed advantage is desired. Once the lockon has been accomplished and there are no indications of possible break-lock or transfer-lock evident, maximum practicable speed should be used. This reduces target penetration and provides an increased AIM-7 capability. The stern attack has the following disadvantages:

a. It is susceptible to target jinking.
b. It provides no capability against an ASM.
c. It increases raid penetration distance.
d. The missile is more vulnerable to countermeasures than in a head-on attack.

(C) The beam approach may be used against medium altitude subsonic targets but should be converted to a head-on, front-quarter, or stern attack whenever possible. Since the medium altitude subsonic target is considered to be the prime ECM threat, beam attacks should be avoided.

(U) ATTACK AGAINST AN ASM

(C) Short and medium range (50 to 100 miles) air-to-surface missiles have speed and altitude characteristics similar to manned aircraft. Since the exact flight profile of an expected ASM is not known, it is impossible to propose a minimum range for shifting an attack from the parent aircraft to the ASM. The decision of whether to attack the missile or continue the attack on the bomber must be made by the aircrew or air controller. Current intelligence publications should be studied to ascertain the ASM flight profile and guidance. Attack geometry against the ASM should be the same as that used against aircraft of similar speed and altitude. One exception is that the ASM probably has no chaff capability. To attack a supersonic ASM, a head-on attack should be used. A front-quarter attack may be used but the probability of success will be low if track crossing angles less than 135° are involved. The AIM-7 has demonstrated only a marginal capability against this type of target when very high rates of closure are involved. Therefore, it is recommended that the interceptor speed at launch be the lowest practicable speed for the altitude and intercept conditions involved.

Note

Refer to section V, part 2 of the Secret Supplement.

HIGH ALTITUDE SUPERSONIC TARGETS

(U) GENERAL

NEW NEW NEW

(C) Though limited in number, the high altitude supersonic fighter or bomber represents a formidable threat. While the weapon system has some capability of countering this threat, intercepts against high altitude supersonic targets are difficult and require extensive training in tactics and weapon system performance. The fighter or bomber can be expected to operate at speeds up to 3.0 Mach and at altitudes up to 80,000 feet. Considering early warning radar detection ranges and interceptor performance characteristics, the intercept can be expected to occur during acceleration, climb, or the supersonic dash. The bomber can be expected to commence a supersonic dash about 150 to 200 miles from the bomb release point. Therefore, if the target is detected prior to its acceleration, initial evaluation of the target will be very difficult. Before acceleration, it will usually be cruising at subsonic speed and at medium altitude. The key to identifying this type of threat is the acceleration to supersonic speed. There will be delays in recognizing a speed and/or altitude increase during the acceleration and dash of the target. Therefore, as soon as the supersonic speed of the target is recognized, the air controller should evaluate the target as a high altitude supersonic raid. The high altitude supersonic target should also be expected to employ ECM which will make the intercept more difficult. At these speeds and altitudes, the aircrew has much less time to analyze the countermeasures and take appropriate action. The primary bomber defenses are high altitude, high speed, and ECM equipment.

(U) HIGH ALTITUDE TACTICS

(C) The air controller employs radial vectoring to establish a forward hemisphere approach to the target. From this approach, a head-on attack is recommended against a high altitude, supersonic target. The highest probability of AIM-7 success against this type of threat is realized when the missile is launched co-altitude and at mid-range from a head-on attack. The aircrew should attempt to achieve this firing position even if airspeed must be sacrificed in the climb. The head-on attack is relatively insensitive to interceptor speed provided that sufficient speed is maintained to complete a co-altitude attack.

NEW NEW NEW NEW

A speed of 1.5 Mach permits maneuvering to counter some target jinking or vectoring error, permits climb to co-altitude (if possible), and provides some economy in fuel consumption. Speed increases beyond 1.5 Mach do not sufficiently increase interceptor maneuverability or decrease raid penetration distance to warrant the fuel required. If the fighter or bomber is at true airspeeds of 1800 knots or greater (3.12 Mach at 80,000 feet), the AN/APG-59 pulse doppler mode has no capability of detecting it and the RIO must use the pulse mode. Also, total prf eclipsing may occur at high closing velocities, denying the use of the pulse doppler mode.

(U) FORWARD HEMISPHERE ATTACKS

(U) Altitude Requirements

(C) When committed to an attack on a high altitude supersonic target, the interceptor should accelerate at maximum power following optimized flight path. After acceleration to 1.5 Mach, a climb should be made to approximately 42,000 feet where speed and altitude should be stabilized until target detection. When the target is detected, the interceptor is in position to make any maneuver required to achieve the best missile launch position. A climb to co-altitude or within 3000 feet of the target altitude should then be made. When this altitude is achieved, launch the missile at mid-range (9 miles, AIM-7E). If the target is not detected when the target range is 40 miles, the interceptor should climb to an altitude 3000 feet below the target altitude transmitted by the air controller. When the target altitude is above 55,000 feet, the interceptor should maintain 50,000 feet for a missile launch at maximum range.

(U) Snap-Up Attacks

(C) A snap-up attack should only be made when late target detection or maneuvering for position results in insufficient time for acceleration and climb. In a snap-up attack, AIM-7 capabilities are maximized if launched from mid-range with the aim dot centered in elevation or slightly low. If the aim dot is high in the ASE circle at launch, the intercept problem is made more difficult for the missile, particularly in band C autopilot constants.

(U) Heading Corrections

(C) Heading corrections, required to correct for vectoring errors or target jinking, are relatively simple at medium altitude and at subsonic speed. Against high altitude supersonic targets, however, the effects of high closing velocities become apparent on required heading changes. Therefore, heading changes required to maintain a collision course must be made rapidly and usually in twice the magnitude required for subsonic lower altitude targets. After the target has passed the R_a strobe, corrections should be made as necessary to keep the aim dot centered. High altitude supersonic targets are not expected to use excessive evasive maneuvering to counter an interceptor attack. Interception of these targets is usually made during the acceleration, climb, or dash phase of the bomber flight profile. During these phases, bomber heading changes are restricted to relatively small corrections required to reach the bomb release point. Large altitude changes, except during the climb phase, are also not within the capability of the target. The primary mission of the bomber is to achieve a satisfactory bomb drop on the target, not to counter interception by heading or altitude changes.

(U) REAR HEMISPHERE ATTACKS

(C) While the weapon system is optimized in a head-on attack against high altitude supersonic targets, such attacks are not always possible. Attacks from the rear hemisphere, though inherently disadvantageous when considering increased raid penetration distance and fuel consumption, are recommended if a head-on attack cannot be made. These attacks require extremely precise air controller and aircrew control to achieve a satisfactory missile launch position. To permit a margin for vectoring error and to allow for speed loss in turns, maximum power should be used to achieve maximum possible speed. The tactics for rear hemisphere attacks against high altitude supersonic targets are basically the same as those for low or medium altitude targets. Provisions must be made by the air controller and the aircrew for increased turning radii and expected speed loss without additional power in turns. The interceptor should maintain an altitude between 30,000 and 35,000 feet for maneuverability. AIM-7E launches with band C autopilot constants are feasible from a rear hemisphere attack since closing velocities are much lower than in a head-on launch. Snap-up tactics are also recommended for both AIM-7 and AIM-9 launches from a rear hemisphere attack. Visual rear hemisphere attacks against high altitude supersonic targets are both practical and desirable if these targets are in the contrail level and can be visually detected at extreme ranges. If the pilot detects the target visually before radar detection, he should take control of the intercept and maneuver for a rear hemisphere attack. Due to the high closing velocities involved, these attacks require extensive practice and aircrew coordination. They have proven effective for both AIM-7 and AIM-9 launches.

(U) BEAM ATTACKS

(C) Beam attacks against high altitude supersonic targets should be avoided because of missile guidance problems in this area resulting from chaff and missile antenna gimbal limits. If AIM-7 missiles must be launched in the beam area, the effects of the missile guidance problem can be minimized if the missile is launched at maximum range with the interceptor at co-altitude and with maximum speed possible.

VERY HIGH ALTITUDE SUBSONIC TARGETS

(U) GENERAL

(C) These targets are usually single airplanes launched to provide reconnaissance information or to provide terminal guidance for IRBM or long range ASM. They could distinguish individual ships for target designation or act as forward controllers of the missiles. The estimated airspeed and altitude of these airplanes are 0.8 Mach at 70,000 feet. Their prime defense is their extreme altitude.

(U) ACCELERATION AND SNAP-UP

(C) The interceptor performance allows a wide range of altitudes, airspeeds and ranges from which to perform the snap-up against very high altitude subsonic targets. However, aircrews and controllers must use proper techniques in executing the snap-up. The timing of the acceleration to supersonic speed is an important factor, since late acceleration could result in a missed intercept. To reduce acceleration time and distance, it is recommended that the tanks be dropped, whenever possible, prior to the attack.

(U) ALTITUDE CONSIDERATIONS

(C) Climb angles greater than 30° can cause the interceptor to gain excessive altitude when the entry speed and altitude are more than 1.5 Mach and 35,000 feet. If the pilot suspects that very high altitudes are being achieved, he should monitor the engine instruments closely. Do not rely solely on the altimeter as it may stick. For additional information on zoom climbs, refer to section IV of NATOPS Flight Manual, NAVAIR 01-245FDB-1 or NAVAIR 01-245FDD-1.

IN-TRAIL TACTICS (ALL WEATHER)

(C) The use of in-trail tactics permits a single air controller to coordinate the efforts of more than one interceptor. In-trail tactics are used for identification procedures and to allow the simultaneous use of more than one interceptor against a particular raid. The effectiveness of in-trail depends upon how they are employed and how proficient the aircrews are in maintaining the desired position. The spacing between the interceptors depends on the type of intercept being performed. For stern attacks, a 2 to 3-mile spacing should be used. For head-on or front-quarter attacks, a 10 to 15-mile spacing should be used. The beam attack spacing depends on the tactical situation. The greater the overtake on the target, the greater the spacing required. Sufficient distance must be maintained between interceptors to allow the first interceptor time to launch missiles and clear the area before the second interceptor reaches R_{max}. To obtain an in-trail position after takeoff, roll out on the climb vector and note the azimuth position of the leader on the radar scope. If the leader is not at zero azimuth, his flight path is being paralleled. In this situation, determine the degrees of azimuth error; turn one-half of this amount toward the leader, and roll out. This action causes the leader's target return to move approximately one half the previous error toward the scope center. This correction heading should be maintained until the leader's target return has moved to the opposite side of zero azimuth an amount equal to the

(C)
heading difference from the actual vector. A direct trail position has then been established and a turn to the original course should be made. Once the trailing aircraft is in position, the pilot must continue to fly along the same flight path as the lead aircraft. A step-down of approximately 1000 feet is recommended to avoid jet wash and to improve radar performance. Once a turn is given to the flight, the trailing aircrew must calculate the time to initiate their turn to maintain the desired position. This is determined by the distance between the aircraft and by the true airspeed. The closer the trail position and the higher the airspeed, the sooner the trailing aircraft must initiate its turn. With higher true airspeeds, the turning rate will be less. Therefore, the lead aircraft moves less in azimuth before the second aircraft initiates its turn. For a 2 to 3-mile spacing, the second aircraft should initiate its turn approximately 15 seconds after the leader and when the leader is 10° to 15° from zero azimuth. For a 10 mile spacing, the turn should be commenced approximately 60 seconds after the leader and when the leader is 30° to 35° from zero azimuth. Normal in-trail maneuvering should be flown with the radar in the search mode. This enables the trailing RIO to monitor the radar for possible malfunctions and also maintain cognizance of the entire tactical situation. Depending on radar performance, he may also detect the target before the leader and direct him onto the target. Once the final attack vector is initiated, the second RIO should not hurry target lockon. Instead, he should determine the tactical situation and the flight path the leader is employing to attack. This is especially important if the raid consists of multiple targets or is employing ECM. For a stern attack, the interceptors should fly close trail (2 to 3 miles) and make an in-trail turn to the attack heading. Forward hemisphere attacks should be made from an in-place turn to final attack heading so that the interceptors will be in echelon. It is important that the two interceptors employ the same bank angle and airspeed during the final turn. The trailing interceptor should lockon when the final attack turn is commenced or early in the turn. Precise matching of turn rates and airspeed will ensure proper separation when the trailing pilot is commencing his attack and devoting less attention to maintaining a trail position. The lead aircraft, after a missile launch from a stern attack, should turn away from the direction of the final attack turn to a heading 90° from the target heading. The trail aircraft is clear to fire when the lead aircraft has completed 45° of the breakaway turn. If a raid of multiple bombers is being attacked using in-trail tactics, the air controller should assign an outside target to the lead aircraft and an inside target to the trail aircraft. In this way, the lead aircraft will swing wider on the final attack turn and a crossing situation will not exist when the lead aircraft commences the breakaway turn. If a single target is being attacked by both aircraft and the lead aircraft can assess his missile damage as lethal, he should immediately broadcast a SKIP IT to the trail pilot. Recovery of the in-trail position after breakaway is a problem regardless of how all procedures prior to the attack are flown. If the attack is against a single target and the trail aircraft uses the same breakaway procedures as the lead aircraft, the two aircraft should be in some semblance of a trail formation after the breakaway turn. The air controller can adjust the aircraft positions if the pilots cannot do so themselves. If the trail formation has attacked separate targets in the same raid, they will be widely separated after the breakaway turn. The pilots must then depend on the air controller to effect a join-up.

REATTACK

(C) The following procedures are for reattacks against enemy bombers. For fighter vs fighter reattack, refer to part 1, this section. One of the advantages of the weapon system is the capability to reattack a raid after the initial attack. The reattack maneuver requires time and fuel and permits the raid to penetrate further toward the vital area. Therefore knowledge of reattack feasibility prior to the initial attack is important. Depending on the proximity of the raid to the vital area and on fuel remaining, the interceptor may salvo all missiles on initial attack or launch a single missile and reattack. The reattack maneuver can either be controlled by the air controller or by the aircrew. When the reattack is controlled by the air controller, the interceptor will be directed to a position to commence a new attack after the initial attack is completed. This type of reattack allows greater target penetration distance than an aircrew controlled reattack. However, it is a more reliable and selective method. With controller assistance, high closing velocity reattacks against bombers can be made with a minimum of interference from defending fighters. For this type reattack, the air controller should position the interceptor for either a cut-off or stern attack. The cut-off attack should be used if the tactical situation allows additional target penetration and requires a high closing velocity at intercept. The aircrew controlled reattack is conducted against the same raid by the aircrew. This type reattack is accomplished by using a preplanned procedure and a knowledge of target heading, altitude, and airspeed. The aircrew controlled reattack has the advantage of minimizing target penetration between attacks. However, it has the disadvantage of being unreliable. Any aircrew errors may be compounded by raid jinking or incorrect raid heading, altitude, or airspeed information. Aircrew controlled reattacks are more expeditious when made from a front-quarter attack. The head-on attack reduces raid penetration but requires more time to obtain the lateral displacement required before starting the turn back to the target heading. The beam position is the least desirable for an AIM-7 attack/reattack. The reattack (figure 1-75) should be initiated immediately following launching the last missile in the forward hemisphere area by a nose-down turn into the direction of the target approach. This turn causes the target to break across the nose

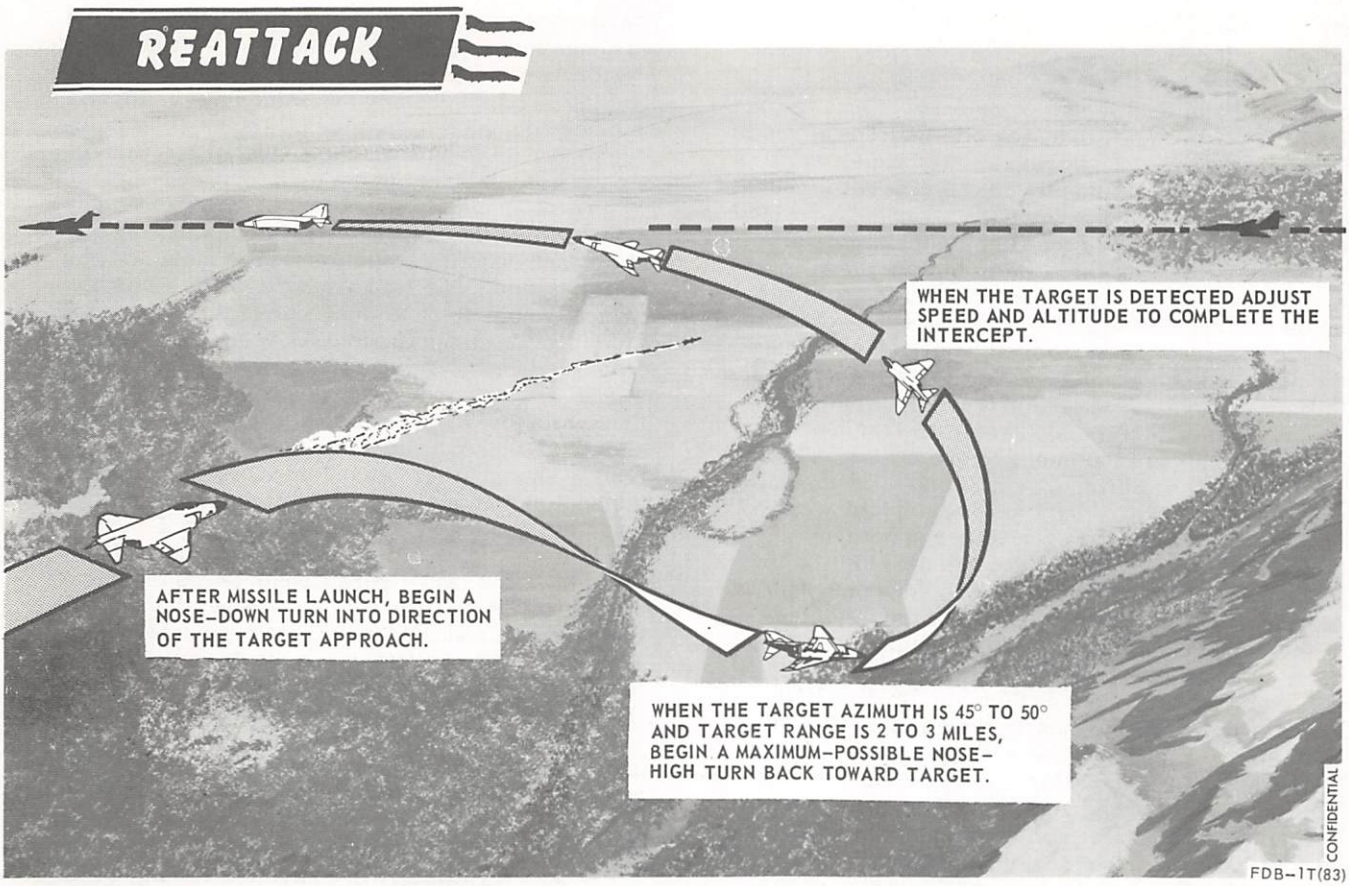


Figure 1-75 (C)

(C)
of the interceptor. A nose-down turn helps to maintain interceptor speed and allows for optimum acceleration. Maximum power should be used in the displacement turn and the speed should be increased to a minimum of 1.2:1 ratio over that of the target. The lateral displacement required depends upon the altitude, speed, and initial attack aspect. When the attack is made from the front-quarter, the displacement turn should usually be held until the target reaches an azimuth of 45° to 50° on the radar scope. At this time, the target range should be about 2 to 3 miles. Radar track must not be lost in the displacement turn to ensure target illumination for the AIM-7 missile. After the required displacement is attained, the interceptor should commence a maximum-possible, nose-high turn back toward the target. Maximum power should be used as required to prevent loss of speed in the turn. If radar track is lost, the turn should be continued at least 30° past the last known target heading or until radar detection is obtained. If radar detection is obtained, the interceptor speed and altitude should be adjusted to complete the intercept. If the target is not detected upon completion of the reversal turn, continue the turn for an additional 30°.

DATA LINK

(U) DESCRIPTION

NEW NEW

(C) The AN/ASW-25A data link system, installed in F-4B/N and F-4J, is a UHF data link receiver used in conjunction with naval tactical data system (NTDS) equipped ships, airborne tactical data system (ATDS) equipped aircraft, and marine tactical data system (MTDS) equipped stations. Since the AN/ASW-25A cannot transmit data back to the controlling station, success depends upon the aircrews' ability to accurately interpret and respond to the commands and information displayed on the aircraft indicators. Correct utilization of data link is predicated on a thorough knowledge of ATDS/NTDS capabilities, procedures, vector phase control, and limitations.

(U) CAPABILITIES

(C) Data link or link 4A used in conjunction with the ATDS and NTDS greatly enhances the fleet anti-air warfare (AAW) picture. It provides rapid, computer aided, tactical evaluation of the entire AAW picture and instantaneous dissemination of tactical information to the fighter and other combat stations. With data link, each station has the capability to control up to 54 aircraft at line-of-sight ranges up to 300 nautical miles by utilizing a secure communications network and minimum voice transmissions. The ATDS/NTDS computers facilitate target assignment and transmit a continuous stream of target information to the fighter. This enables early detection and affords the fighter aircrew the best possible chance to complete their mission in the ECM environment. Data link markedly improves the fighter ECCM capability by providing continuous target information and intercept control without radiating the AN/APQ-72 or AN/APG-59 radar. In the strike control role, data link provides vectors to a target or holding point or a handover to other controlling agencies. It also aids in navigation and flight following. It is the fastest and most flexible means of target evaluation and weapon assignment.

Note

Presently configured E-2 aircraft cannot send magnetic bearing information to data link aircraft without deleting the magnetic compass input to their navigation unit. This may result in subsequent drift of their navigation plot.

(U) PROCEDURES

(C) ATDS is capable of transmitting information and commands in two phases: vector phase and strike phase (coarse course direction phase). All target and command information is automatically transmitted by data link from the computer aboard the E-2 aircraft; however, the controller has complete control over information sent to the fighter. NTDS transmits information only in the vector phase. NTDS information may be manually or computer directed to the aircraft. NTDS can update bogey and command information every 4 seconds; ATDS updates bogey and command information every 10 seconds. Except where noted, all of the following procedures and tactics are essentially the same for ATDS and NTDS. Command information is always the heading and altitude the controlling agency desires the fighter to fly. Command information is displayed by the radar scope command dot, the ADI pitch and bank steering bars, the HSI heading marker, the BDHI number one needle, and the command target altitude indicator altitude marker. Target information is displayed by the radar scope target circle (vector phase only), the HSI bearing pointer and distance counter, and the BDHI number two needle and distance counter. Target information may indicate bearing and distance to a target, a tacan station, a base, or any waypoint the controller directs and it is designated by discrete word messages in a manner to be discussed in the following paragraphs.

(U) VECTOR PHASE

(C) The vector phase is the air-to-air (or AAW) portion of the data link. There are two types of control in the vector phase: waypoint control and intercept control.

(C) Waypoint control (or fixed point vectoring) is encountered in station keeping as in BARCAP missions. The waypoint is a computer programmed point designated by the controller to position or hold the fighter. This type of control (most commonly utilized by BARCAP station keeping) is in effect any time the fighter is not assigned a target during the vector phase. When under waypoint vectoring, the digital display indicator (DDI) TO WAYPT (to waypoint) message appears and the target information displays the range and bearing to the waypoint. When the fighter closes to within 10 nautical miles of the selected waypoint, the ATDS automatically transmits the ORBIT message; NTDS continues to transmit the TO WAYPT message. The controller may direct the fighter to return to base by sending the RET BASE message (also a fixed point vector); the target information displays range and bearing to the controlling station while command information displays command heading and altitude to the base or marshall point.

(C) The fighter is under intercept control the moment it is assigned a target. When target assignment occurs, the TO WAYPT or ORBIT message disappears and the target information now displays bearing and distance to the bogey. The appearance of the target circle on the radar scope at the predicted range and bearing of the bogey is the most reliable indication of target assignment. All intercept geometry is preprogrammed into both the ATDS and NTDS computers. The intercept profiles are predicated on F-4B/N and F-4J performance specifications and radar gimbal limits of ± 60°. Unless otherwise requested, the computer determines the intercept geometry possible for a given situation based on the following priorities and transmits the corresponding DDI message:

PRIORITY	DDI MESSAGE
180° TCA (head-on)	ARM 3 or CHALNGE
135° TCA (Forward quarter)	ARM 3 or CHALNGE
Less than 90° TCA (Stern)	ARM 2 or CHALNGE
Collision (Uncontrollable TCA)	ARM 1 or CHALNGE

Note: ARM - if destroy
CHALNGE - if identify

(U) ATDS/NTDS Intercept Profiles

(C) Upon the initial turn to the bogey, DDI displays CHALNGE (challenge) message if the fighter is to identify the bogey or the ARM 1, ARM 2, or ARM 3 message if the fighter is to destroy the bogey. The number following the destroy command indicates the type of intercept. Target information displays the bogey bearing and distance from the fighter. Command information displays the command heading and altitude for the run-out leg.

(C)

a. Run-out leg - The run-out leg is the initial course for closing on the bogey and its length varies with the particular intercept (figures 1-76 and 1-77).

b. Attack leg - Fighter turns to firing heading for the attack leg. If the fighter does not take control of intercept before bogey range decreases to 10 nautical miles, ATDS directs the fighter to a pursuit intercept (stern attack). In this situation, NTDS programs a standard rate turn to bogey heading at 8 nautical miles. At this point in the intercept, the F-4 aircrew must be judicious in following data link commands. Strict adherence to commanded headings in the final phase of an intercept can result in the F-4 turning in front of the bogey.

(C) Refer to figure 1-78 for altitude profiles programmed by the ATDS and NTDS. Command Mach selections for the run-out and attack legs are as follows:

TARGET ALTITUDE	RUN-OUT LEG	ATTACK LEG*
Very High (above 55,000)	Mach 1.4	Mach 1.4 for forward quarters. Twenty percent speed advantage or Mach 1.4, whichever is greater, for other than forward quarters.
High (40,000 - 55,000)	Mach 1.4	Mach 1.4 for forward quarters. Twenty percent speed advantage or Mach 1.4, whichever is greater, for other than forward quarters.
Medium (15,000 - 40,000)	Mach 0.9	Mach 0.9 for forward quarters. Twenty percent speed advantage or Mach 0.9, whichever is greater, for other than forward quarters.
Low (0-15,000)	Mach 0.8	Mach 0.8 for forward quarters. Twenty percent speed advantage or Mach 0.8, whichever is greater, for other than forward quarters.

* For rendezvous missions, the 20 percent speed advantage is gained after the start of the final turn.

(C) Turns programmed by ATDS and NTDS are as follows:

ATDS

Subsonic - 30° bank angle. 20° bank angle for final turn in tail-on stern attack.

Supersonic - 45° bank angle. 30° bank angle for final turn in tail-on stern attack.

NTDS

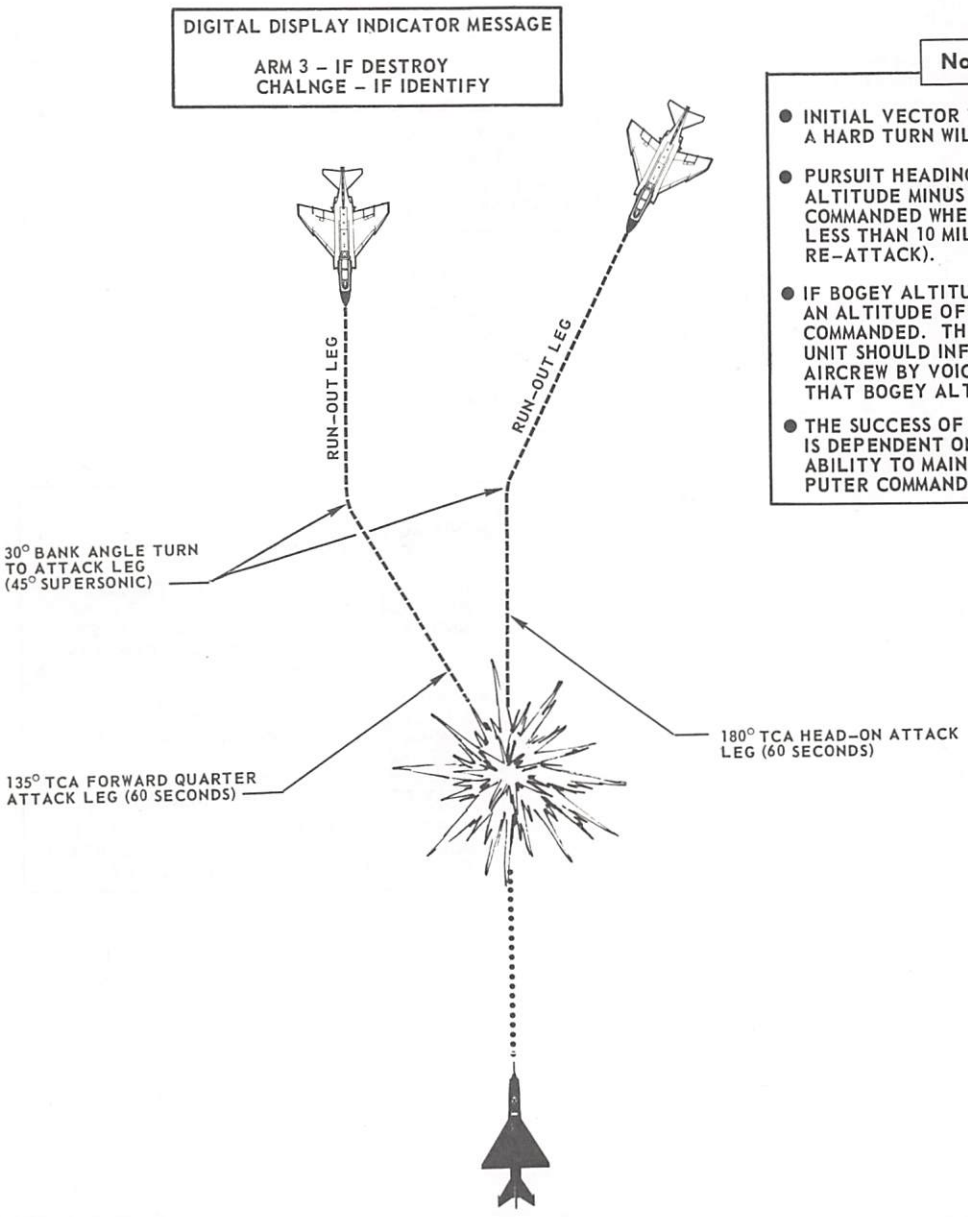
Subsonic - 30° bank angle.

Supersonic - 45° bank angle.

(C) ATDS/NTDS discrete messages displayed on the DDI and CDI (command display indicator) have the following implications:

DISCRETE MESSAGE	BRIEF DESCRIPTION	EXPANDED DESCRIPTION
None	No statement	Control station has no discrete message for interceptor.
NOT CMD	Not under command	Ignore command heading, speed, and altitude and target information until a new discrete is received. Take action in accordance with doctrine, briefing, or voice commands.
TO WAYPT	Vector to waypoint	Proceed to the point indicated by target information. Command heading, speed, and altitude may be used, if desired.
HANDOVR	Handover	Interceptor is being vectored to a point where control will be transferred to another control agency. Expect further instructions concerning next voice frequency and data link channel assignments. If new data link channel and voice frequency are known, handover may be executed on receipt of HANDOVR message.
ORBIT	Orbit	Remain in the immediate vicinity of present position using pattern established by SOP or briefing.

HEAD-ON OR FORWARD QUARTER APPROACH GEOMETRY



Note

- INITIAL VECTOR TO BOGEY ASSUMES A HARD TURN WILL BE MADE.
- PURSUIT HEADING AND TARGET ALTITUDE MINUS 2000 FEET ARE COMMANDED WHEN TARGET RANGE IS LESS THAN 10 MILES (SIMULATE RE-ATTACK).
- IF BOGEY ALTITUDE IS UNKNOWN, AN ALTITUDE OF 20,000 FEET IS COMMANDED. THE CONTROLLING UNIT SHOULD INFORM THE F-4 AIRCREW BY VOICE TRANSMISSION THAT BOGEY ALTITUDE IS UNKNOWN.
- THE SUCCESS OF THE INTERCEPT IS DEPENDENT ON THE PILOT'S ABILITY TO MAINTAIN THE COMPUTER COMMANDED PROFILE.

AIRCRAFT INDICATORS DISPLAY FOLLOWING DATA SENT BY CONTROLLING AGENCY:

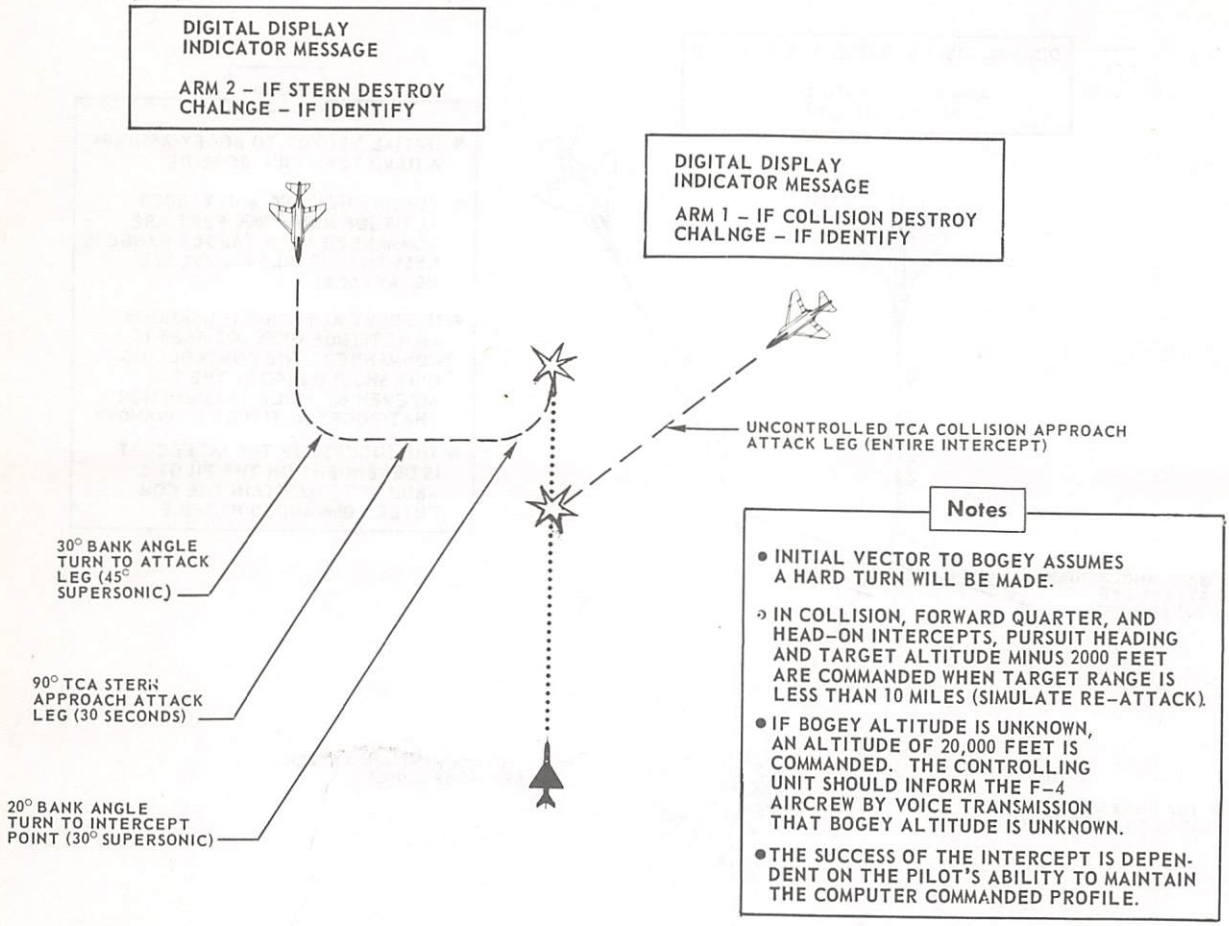
1. TARGET RANGE AND BEARING FROM INTERCEPTOR.
2. COMMAND HEADING
3. COMMAND ALTITUDE
4. MISSION DISCRETE MESSAGES

CONFIDENTIAL

FDB-1T-(84)

Figure 1-76 (C)

STERN AND COLLISION APPROACH GEOMETRY



AIRCRAFT INDICATORS DISPLAY FOLLOWING DATA SENT BY CONTROLLING AGENCY:

1. TARGET RANGE AND BEARING FROM INTERCEPTOR.
2. COMMAND HEADING
3. COMMAND ALTITUDE
4. MISSION DISCRETE MESSAGES

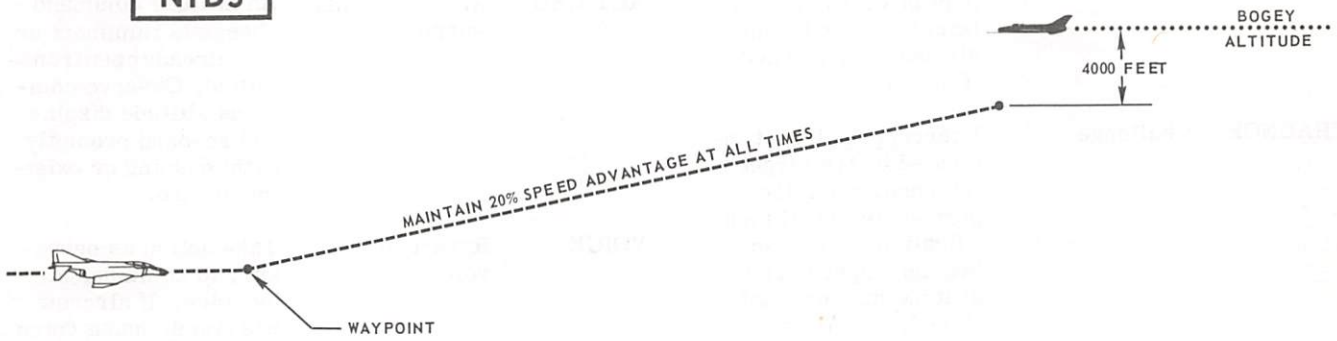
CONFIDENTIAL

FDB-1T-(85)

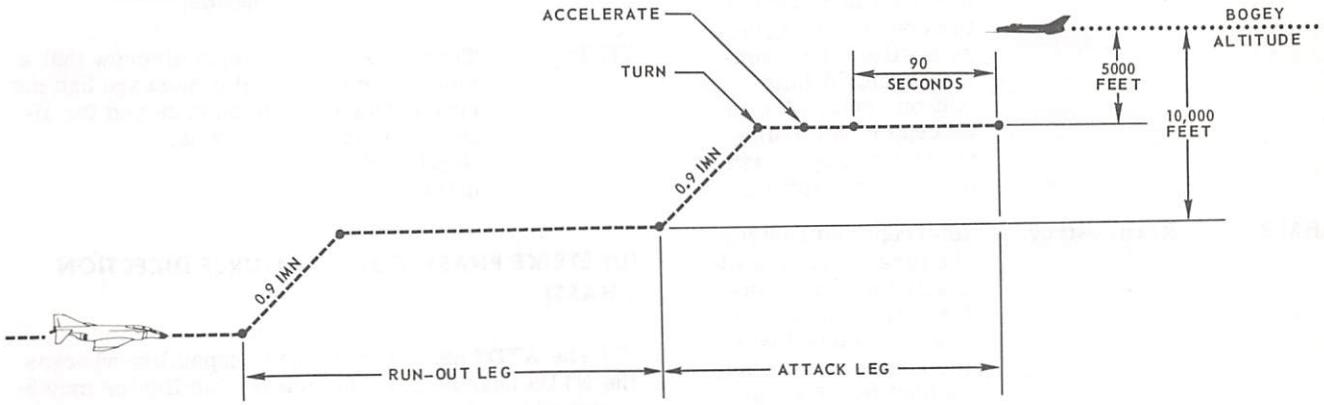
Figure 1-77 (C)

ALTITUDE PROFILES

NTDS



ATDS



Note

- THE SUCCESS OF THE INTERCEPT IS DEPENDENT ON THE PILOT'S ABILITY TO MAINTAIN THE COMPUTER COMMANDED PROFILE.
- IF BOGEY ALTITUDE IS UNKNOWN, AN ALTITUDE OF 20,000 FEET IS COMMANDED. THE CONTROLLING UNIT SHOULD INFORM THE F-4 AIRCREW BY VOICE TRANSMISSION THAT BOGEY ALTITUDE IS UNKNOWN.

CONFIDENTIAL

FDB-1T-(86)

Figure 1-78 (C)

(C)

DISCRETE MESSAGE	BRIEF DESCRIPTION	EXPANDED DESCRIPTION
RET BASE	Return to base	Proceed to point indicated by target information. The point represents place at which the aircraft may land. Command heading, speed, and altitude may be used, if desired.
CHALNGE	Challenge	Intercept the target indicated by the target information for the purpose of visual identification. Command heading, speed, and altitude may be used, if desired. After identification, take action in accordance with doctrine, briefing, or voice command.
ARM 1	Collision	Intercept and destroy the target which is indicated by target information and which has been identified by the controlling agency as hostile. The command control information vectors the interceptor on a collision course approach to the indicated target.
ARM 2	Stern destroy	Intercept and destroy the target which is indicated by target information and which has been identified by the controlling agency as hostile. The command control information vectors the interceptor on a standard rear hemispheric approach to the indicated target.
ARM 3	Forward destroy	Intercept and destroy the target which is indicated by the target information and which has been identified by the control station as hostile. The command control information vectors the interceptor on a standard forward hemispheric approach to the indicated target.
DIS'GAGE	Disengage	Cease fire or do not fire. Take immediate action in accordance with doctrine or briefing.
ALT CHG	Altitude change warning	An altitude command change is imminent or has already been transmitted. Observe command altitude display and respond promptly to the ensuing or existing change.
VOICE	Revert to voice	Take action as necessary to communicate by voice. If aircrew has simultaneous voice and data reception from the same control agency, the next message heard on the voice communications is intended for you.
CMD CNTRL	Command control	Message indicates interceptor is receiving valid data link information.
TILT	Transmission of intercept and landing information terminated.	Alerts aircrew that a valid message has not been received for 10 seconds.

(U) STRIKE PHASE (COARSE COURSE D!RECTION PHASE)

(C) The ATDS has a strike phase capability whereas the NTDS does not. In this phase, the fighter may be vectored to a holding point for handover, to precision course direction like TPQ-10, or to a scheduled or unscheduled target. Strike phase also includes flight following to and from the target area and navigation update assistance.

(C) LIMITATIONS

1. The AN/ASW-25A is a receiver only and cannot transmit data link information to the controller. Voice backup is a necessity.
2. The AN/ASW-25A has no capability to accept command speed messages from link 4A. This severely limits intercept corrections and control. All speed changes must be initiated by voice.
3. In the present AN/ASW-25A, there is no nondiscrete message indicator for target assignment; therefore, constant monitoring of the radar scope and indicators is necessary.

(C)

4. ATDS/NTDS radars cannot accurately track a random maneuvering aircraft. In order to assure good control of the fighter and the intercept, all deviations from command heading and altitude, including unprogrammed maneuvers, must be reported to the controller.
5. If no radar lock is obtained by the F-4 by 10 miles, the aircrew must carefully evaluate the command headings transmitted via Link 4A, realizing that these headings could possibly turn the F-4 in front of the bogey.

PART 7 MISSILE FIRING EXERCISE

(U) The most desirable method of conducting a missile firing exercise is to simulate a combat missile firing, since it is the only complete test of aircrew and weapon system readiness. Missile firing exercises under realistic but controlled conditions provide a means of keeping the aircrew proficient in operation of the weapon system. An important by-product of these firing exercises is the training of maintenance and ordnance personnel, ensuring complete operational proficiency. Stereotyped tow target shoots should only be used as a last resort.

AIR INTERCEPT MISSILES

(U) AIM-7 PROCEDURES

(C) The facilities and personnel required to conduct an AIM-7 firing operation consist of firing aircraft and chase aircraft, tow aircraft (some exercises) and target systems, GCI/CCI control, area clearance, and an officer conducting the exercise (OCE) or competitive exercise observer. The firing area can be checked for surface ships either by AEW aircraft, surface search radars, or by any of the AI radar equipped aircraft in the exercise. The AIM-7 does not incorporate a self-destruct feature and will usually fall in one piece if the warhead does not detonate. Splash patterns for AIM-7 firings can be determined from figure 1-79. The air control radar and the AI radar can be used to check the firing area for non-exercise air traffic. The following procedures are applicable:

a. Whenever a BQM-34A missile target is available, the maneuvering firing exercise flown by the Navy Fighter Weapons School should be utilized. The formation consists of two aircraft flying the standard combat spread under positive control with the firing range facility. All initial set-ups commence from the forward quarter area. The actual engagement commences from the VID position with two-on-one tactics as described in this section. Engaged maneuvering will be flown with TACLEAD and TACWING shifting as the situation dictates. One aircraft is cleared to fire as the opportunity presents itself; the other aircraft will remain clear and act as coverman and safety observer. The second aircraft may fire when the first shooter is clear, however, the following safety parameters must be observed.

(1) No firing without positive location of wingman. Free fighter SAFE, engaged fighter ARMED.
(2) No AIM-7 firing when wingman is within ± 30° of firing aircraft nose unless wingman/bogey TCA is greater than 150° and proper V_C is observed.
(3) No AIM-9D firing when wingman is within 50° of shooter's nose unless TCA on wingman is greater than 120° and then no closer than 30° of shooter's nose.

Note

Engagement continues until both aircraft have expended one AIM-7 and one AIM-9, target is downed, the set time limit is reached, or SKIP-IT is called by any participant.

NEW

The BQM-34A will remain straight and level during the VID; however, if a headon VID is conducted by the firing aircraft the BQM should be broke into the section at 4 miles and remain in a maximum maneuvering condition. The firing aircraft must call HOT-SHOT prior to reaching the AIM-9 firing position (lead time may be as long as 15 seconds depending on type of flare being used). Since the maximum range time available using a clean BQM-34A is 30 minutes, several sections of F-4's should be airborne and standing by, and a time limit set on every engagement.

b. Since free flight targets are not presently available to all fleet squadrons, a towed target may be used for AIM-7 firing. The tow speed should be determined by the OCE to approximate the requirements of FXP-2.

c. In order to avoid confusion and possible misunderstanding on the part of the firing aircrew, the air controller will not furnish the tow aircraft with bearing and distance to the firing group; all ranges and bearings will be given from the firing aircraft to the target. Since all exercise aircraft are on the same radio frequency, the tow pilot can easily determine the relative position of the firing group from the target information and the vectors given to the firing aircraft.

d. When there is any doubt as to the presence of a target on the tow wire, a visual confirmation will be made prior to a firing run.

AIM-7 SPLASH ZONES

AIM-7D

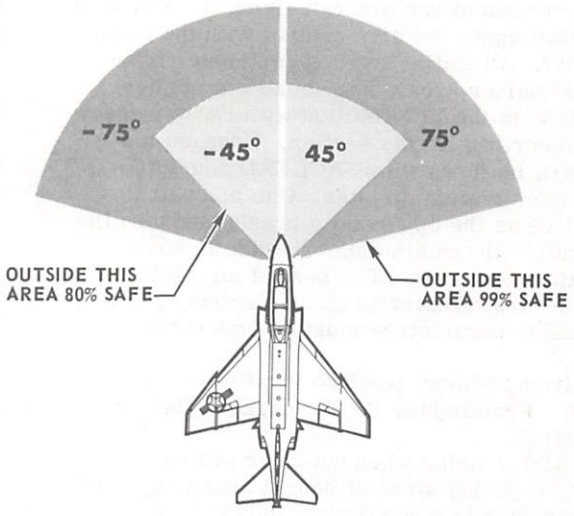
FIRING ALTITUDE - 1000 FEET																
	5		10		20		30		40		50		60		70	
	NOSE-UP ATTITUDE – DEGREES															
FIRING MACH	0	30	0	30	0	30	0	30	0	30	0	30	0	30	0	30
	DOWN RANGE – 1000 YARDS															
0.6	19		21	22	26	29	31	35	36	44	41	50	49	56	57	63
0.8	20		22	24	27	32	32	39	38	48	44	57	52	64	60	71
1.0	21		23	26	28	35	33	43	40	53	47	63	55	72	63	80
1.2	21		24	28	30	38	35	47	43	59	50	70	59	80	67	90
1.4	22		25	30	31	41	36	51	45	65	53	78	62	90	71	102
1.6	23		26	32	32	44	37	56	46	71	55	86	65	100	75	114
1.8	24		27	34	33	48	39	61	48	78	57	94	68	111	79	127
2.0			28	36	35	52	41	67	50	86	59	104	71	123	83	140
2.2			29	40	36	57	43	73	52	96	61	119	74	134	87	154

AIM-7E/E-2

FIRING ALTITUDE - 1000 FEET																		
	1		5		10		20		30		40		50		60		70	
	NOSE-UP ATTITUDE – DEGREES																	
FIRING MACH	0	50	0	45	0	45	0	30	0	30	0	30	0	30	0	30	0	30
	DOWN RANGE – 1000 YARDS																	
0.7	18	21	21	23.5	24	29	30.5	41	39.5	58								
0.8	19	22	21.5	25	25	30	31.5	43	40.25	63								
0.9	20	23	22	26.5	26	31	32.5	45	41	68	51	77						
1.0	21	24	22.5	28	27	32	33.5	47	41.75	73	52.5	81						
1.1	22	25	24	29.5	28	33	34.5	49	42.5	78	54	85	59	115				
1.2			25.5	31	29	34	35.5	51	43.25	83	55.5	89	62	118				
1.3					30	35	36.5	53	44	88	57	93	66	121				
1.4							37.5	55	44.75	93	58.5	97	71	124	67.5	146		
1.5							38.5	57	45.5	98	60	101	75	127.5	88	150	100	
1.6							39.5	59	47	100	61.5	105	77	131	90.5	154	103	
1.7									48.5	102	63	109	79	134.5	93	158	106	
1.8									50	104	64.5	113	81	138	95.5	162	109	
1.9									51.5	106	66	117	83	141.5	98	166	112	
2.0									53.5	108	67.5	121	85	145	100.5	170	116	

Note

A plus or minus 45–degree arc on the nose of the firing aircraft will provide 80 percent safety factor for the splash zone and a plus or minus 75–degree arc will provide 99 percent safety factor.



CONFIDENTIAL

FDB-1T-(87)

Figure 1-79 (C)

(C)

e. The tow aircraft and tow escorts are not normally required to be equipped with AI radar unless directed by higher authority for the specific firing exercise. However, AI radar equipped escorts are an additional safety factor since they are able to determine when the firing group is inside minimum missile range.

f. The voice procedures for firing exercises are listed in figure 1-80. It is mandatory that all participants exercise strict radio discipline. Normally, transmissions should be made only by the air controller, firing aircrew, tow aircrew, and the OCE. This is not to preclude any participant from transmitting SKIP IT if a dangerous situation should develop.

NEW

g. The CLEAR TO FIRE may be given by the OCE, the tow pilot, or the tow escort. The criteria for making this transmission should be completely understood. The following are the minimum requirements for a CLEAR TO FIRE:

(1) There are no surface of air targets, except for participating aircraft, within or approaching the predicted splash pattern of the missile.

(2) The firing group is passing clear of the tow aircraft. This may be verified either visually by the OCE or the tow pilot, or by radar if an AI radar equipped escort is available.

(3) The firing RIO has reported CONTACT, RENO, and JUDY. To ensure that the firing aircraft has locked on the target, the firing RIO should transmit the range to the target every 5 miles. No RENO by the time the range has decreased to 8 miles, is cause for SKIP IT.

NEW

(4) The firing pilot has reported a steady SELECT light. If missile telemetry is being used, absence of telemetry carrier signals or evidence of malfunctioning missile system is reasonable cause for SKIP IT.

NEW

(5) The tow pilot or the OCE has visually sighted the firing group passing safely or the tow escort aircraft has definitely established on radar that the firing group has passed minimum range. CLEAR TO FIRE may be given by the OCE or tow pilot depending upon which calls TALLYHO first. The tow escort pilot may give a CLEAR TO FIRE if he has transmitted CONTACT on the firing group during the firing run and has made a visual sighting on the firing group.

h. If the missile does not launch when the trigger is pressed, the firing pilot will transmit HUNG MISSILE. He will then place the missile arm switch to SAFE and the missile power switch to OFF. The firing pilot will check these switch positions and transmit ALL SWITCHES SAFE. The OCE will join on the firing aircraft to check the missile condition. If the missile motor is smoking, the missile should be jettisoned immediately. If no smoke is observed, the firing aircraft should be vectored to a clear area. All switches should be returned to ON and ARM and the aircraft orbited for 15 minutes. If the missile does not fire during this period, the situation will be treated as a MISFIRE and the firing aircraft will return to base and/or follow local command procedures for ordnance safety.

i. The firing interlocks switch should be in the IN position for all firing. A representative envelope for the AIM-7D can be found in figure 1-81.

j. If a missile is fired inadvertently or prematurely, the firing pilot should immediately turn the missile power switch OFF and the RIO should turn the radar power switch to OFF. This prevents missile guidance signals from being transmitted. Any of the participants, becoming aware of a launched missile which may guide on an aircraft, should immediately transmit LIGHTS OFF. The firing aircrew will then take the action previously noted.

(U) AIM-9B PROCEDURES

(C) The facilities and personnel required to conduct a safe and successful AIM-9B firing operation consist of firing aircraft and chase aircraft, tow aircraft (some exercises) and target system, GCI/CCI radar control, area clearance facilities (radar or air/surface search), and an officer conducting the exercise (OCE). The firing area can be checked for surface ships by either airborne visual observation or by surface/airborne radar search. The AIM-9B impact area is a 20° sector of a radius equal to 8000 yards plus 300 yards for each 1000 feet of altitude. If the firing is made with an angle-off, expand the sector by 10° on the side of the target course away from the attack. These areas must be clear of all surface and airborne traffic from the surface to the firing altitude. The following procedures are applicable for AIM-9B firing operations against towed targets:

a. The exercise will be conducted according to the parameters prescribed by the OCE or FXP-2.

b. Figure 1-83 tabulates the allowable firing parameters. The speeds given are true Mach number. R_{max} is the maximum allowable differential firing range contained in NAVORD 12663. When possible, firings should occur in the center of the envelope to optimize missile performance and crew training. The safety arcs are computed for co-altitude firings at the towed target. The missile launch may occur any time the firing aircraft is outside of this safety arc, provided other envelope parameters of angle-off, tracking rates, and maximum and minimum range are satisfied. The AIM-9B performance is optimized when the missile is fired at reduced angle-off and at ranges which do not approach extreme envelope limits. A representative AIM-9B launch zone can be seen on figure 1-82. For missile firings below 20,000 feet, the angle-off should be within 20° of the targets tail. Refer to NAVORD 12663 for complete missile envelopes if it is desired to fire the missile under other than co-heading conditions. Above 20,000 feet, limit firing angle-off to 40°. Under certain firing conditions with higher angles-off, maximum range increases with angle-off; therefore, safety areas would have to be increased. The safety arc includes a 30 percent safety factor in excess of predicted maximum missile range.

FIRING EXERCISE VOICE PROCEDURES

CALLER	TRANSMISSION	TIME	REMARKS
Firing Pilot	**SELECT LIGHT, AFFIRMATIVE, NEGATIVE, OR INTERMITTENT**	Initial system check immediately after airborne or on request of the air controller or OCE.	If telemetering is available, confirm missile status.
Air Controller	**Vectors as necessary.**	When ready to start run.	Target information relative to tow aircraft until RENO then to target.
Air Controller	**SELECT, ARM, CAMERA ON**	When starting the run.	Pilot selects RADAR and ARM. RIO turns camera on.
Firing Pilot	**SELECT, ARM, CAMERA ON**	When starting the run.	Weapon system ready for firing. Lights on, camera on.
RIO	**CONTACT**	When occurring.	Target is detected on radar scope.
RIO	**RENO**	When occurring.	Transmitted when RIO has definite identification and separation of tow aircraft and target on radar scope.
RIO	**JUDY**	When occurring.	Transmitted when radar lockon is acquired on the target. Should be followed by the range to the target. Lockon should not be attempted without prior RENO.
Firing Pilot	**STANDBY**	When occurring.	One mile beyond R_a.
OCE Tow Pilot Escort Pilot	**CLEAR TO FIRE**	When occurring.	Firing group passing safely. Only time word FIRE is used.
Firing Pilot	**ROGER, CLEAR TO FIRE**	When occurring.	
Firing Pilot	**IN RANGE**	When occurring.	IN–RNG light is on.
Firing Pilot	**FOX ONE**	When occurring.	Trigger squeeze.
Firing Pilot	**AWAY**	When occurring.	Missile observed.
Firing Pilot	**HUNG MISSILE**	When occurring.	Missile has not fired 5 to 6 seconds after trigger is depressed.
Any Participant	**SKIP IT**	When occurring.	Any participant feels run should be aborted for any reason.
Any Participant	**LIGHTS OFF**	If missile appears to be homing on aircraft.	Missile CW power switch and radar power switch to be turned OFF.
THE FOLLOWING TRANSMISSIONS ARE APPLICABLE TO AIM-9 FIRING EXERCISES:			
Firing Pilot	**HOTSHOT**	When occurring.	One mile beyond Rmax. Tow airplane ignites flare. OCE confirm HOTSHOT.
Firing Pilot	**BUZZER**	When occurring.	Pilot is receiving AIM-9 audio. This tone should be transmitted 5 to 6 seconds.
Firing Pilot/RIO	**SUN LAMP**	When occurring	Visual detection of flare.
OCE	**CLEAR TO FIRE**	After BUZZER	OCE has confirmed HOTSHOT and clear area.
Firing Pilot	**ROGER, CLEAR TO FIRE**	When occurring.	
Firing Pilot	**FOX TWO**	When occurring.	Trigger squeeze.
Firing Pilot	**AWAY**	When occurring.	Missile observed.
Firing Pilot/RIO	**BULA BULA**	When occurring	Destroyed target.

CONFIDENTIAL

FDB-1T-(89)

Figure 1-80 (C)

AIM-7D NON-MANEUVERING ENVELOPES

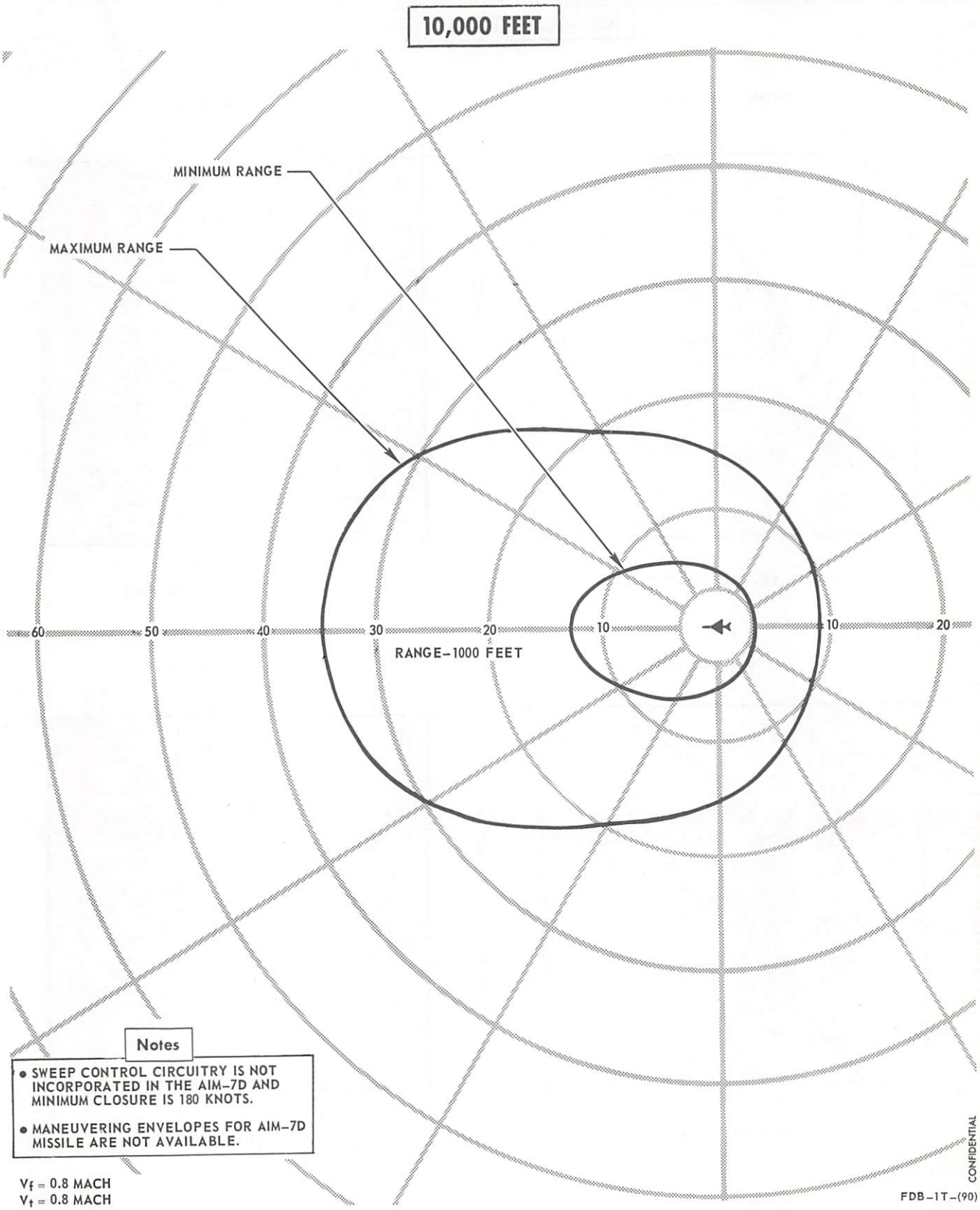


Figure 1-81 (C)

AIM-9B LAUNCH ZONES

NON-MANEUVERING

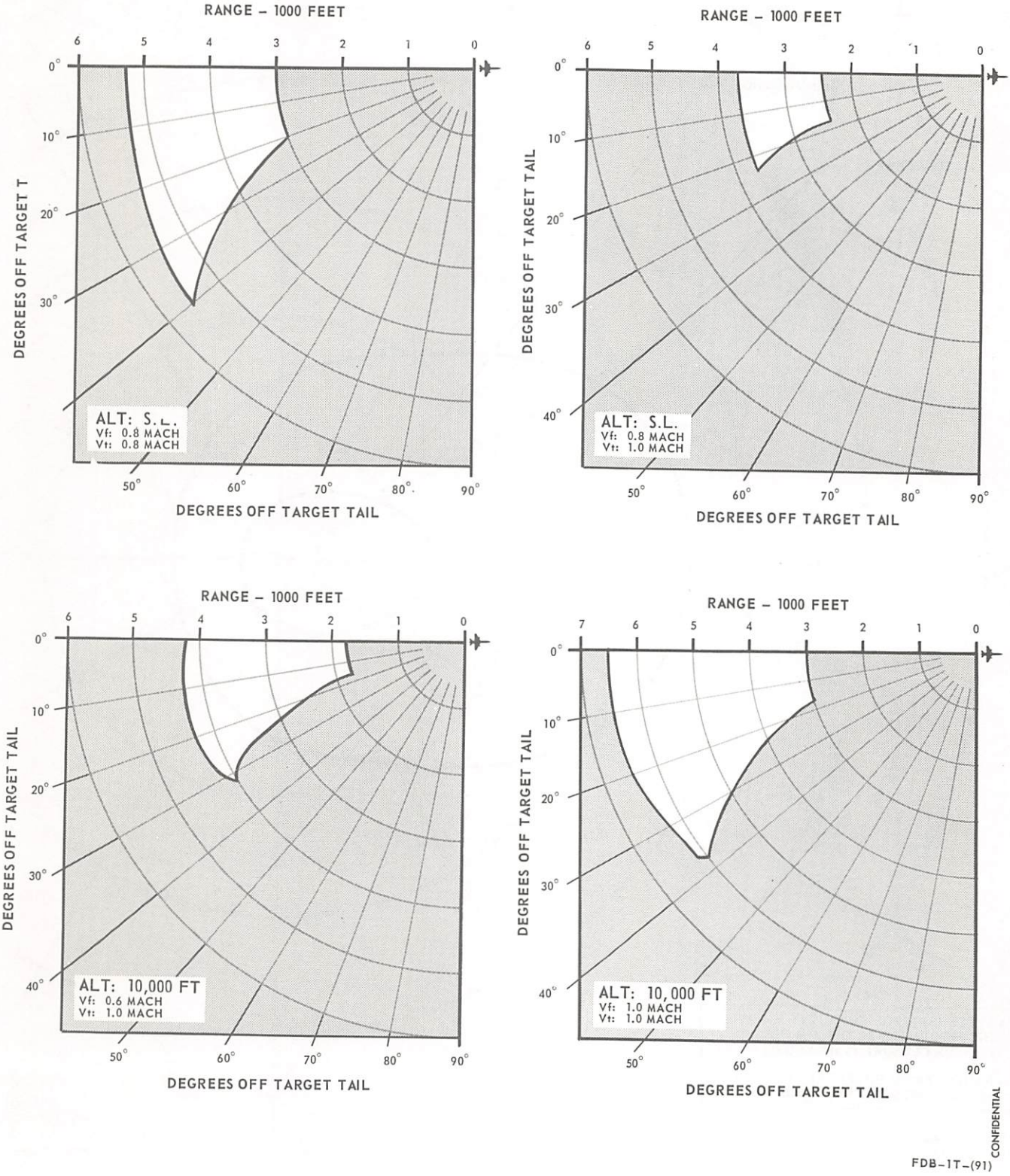


Figure 1-82 (C)

AIM-9B LAUNCH AND SAFETY PARAMETERS

ALTITUDE – 1000 FEET	LAUNCH MACH	TARGET MACH	1 MAXIMUM RANGE-FEET	2 MINIMUM RANGE-FEET	3 TOW AIRCRAFT SAFETY ARC	4 MINIMUM CABLE SCOPE
SEA LEVEL	0.4	0.4	8600	3000	13,500	10,500
	0.5	0.4	9000	3300	14,000	11,000
	0.4	0.4	9300	3600	14,500	11,500
5000	0.6	0.4	12,300	3600	16,000	15,000
20,000	0.6	0.4	17,000	3600	22,500	21,500
	0.8	0.6	14,700	3600	20,000	18,000
	0.8	0.7	12,600	3300	17,500	15,000
30,000	0.8	0.6	19,600	3600	25,500	23,500
	0.8	0.7	17,500	3300	23,000	20,500
	0.9	0.6	20,400	3900	26,500	24,500
	0.9	0.7	18,300	3600	24,000	22,000
	0.9	0.8	16,200	3300	21,500	19,500
	1.0	0.7	19,000	3900	24,500	22,500
	1.0	0.8	17,000	3600	22,000	20,500
	1.2	0.8	18,800	4200	24,500	22,500
	1.2	1.0	14,600	3600	19,500	18,000
40,000	0.8	0.7	21,700	3300	28,000	26,000
	0.9	0.7	22,800	3600	29,500	27,500
	1.0	0.7	24,000	3900	31,500	29,000
	0.9	0.8	20,800	3300	27,000	25,000
	1.0	0.8	21,900	3600	28,500	26,000
	1.2	0.8	24,200	4200	31,500	29,000
	1.2	1.0	20,100	3600	26,000	24,000
	1.4	1.0	22,500	4200	29,500	27,500
	1.4	1.2	18,400	3600	24,000	22,500
	1.6	1.2	26,500	4200	26,500	24,500
	1.8	1.2	22,700	4800	29,500	27,500
50,000	1.0	0.8	27,200	3600	35,500	32,500
	1.2	0.8	29,900	4200	38,000	36,000
	1.2	1.0	25,800	3600	33,500	30,500
	1.4	1.0	28,900	4200	37,500	35,000
	1.4	1.2	24,800	3600	32,500	30,000

1 From NAVORD OD 12663. Applicable to 20 degrees angle-off for low altitudes and 40 degrees for high altitudes. This range should be reduced by 20 percent, even for planned "long range" firings, to account for possible manufacturing deficiencies.

2 Based on formula: $R_{min} = 3000 \text{ ft} + 3000 (\Delta M)$.

3 Includes 30 percent safety factor added to R_{max} (or at least 5000 feet added to R_{max}). Maximum ranges increase beyond 40 degrees angle-off in some instances; therefore, safety arcs are applicable only from dead astern to 40 degrees off the target.

4 Minimum cable scopes are computed by adding 20 percent safety factor to the computed maximum aerodynamic ranges. Adequate safety for the tow aircraft is consistently provided when the firing airplane fires outside of the computed minimum range to the target and within the angle-off parameters. Where the cable scope required for a particular firing exercise is unattainable, it becomes mandatory that the tow aircraft safety arc figures be strictly observed.

CONFIDENTIAL

FDB-1T-(92)

Figure 1-83 (C)

(C)

c. Firing exercise example (figure 1-84):

Altitude -	5000 feet
Target Mach -	0.4 Mach
Launch Mach -	0.6 Mach
Safety arc -	10,000 feet

With a cable scope of 10,000 feet, minimum firing range is 16,000 minus 10,000 = 6000 feet dead astern or a safety arc of 16,000 feet on the tow aircraft. Maximum firing range is 12,300 feet from the towed target. If the tow system allows placing the target outside of the safety arc as in example 2, minimum range applies and launch may occur from any angle-off the target within the missile envelope.

d. The airborne OCE is responsible for the following:

(1) Confirming RENO.
(2) Confirming HOTSHOT by visually ascertaining if the ignition has occurred.
(3) Confirming IN-ENVELOPE.
(4) Giving CLEAR TO FIRE.
(5) Acting as a safety observer for area clearance, missile malfunction, or HUNG MISSILE, and confirming target tracking and not tow aircraft tracking.

e. All participants should exercise strict radio discipline as a safety precaution and for exercise efficiency. Figure 1-80 includes the normal voice procedures used during an AIM-9 firing exercise.

f. CLEAR TO FIRE may be given by the OCE only if the following criteria have been met:

(1) There are no surface or air targets within the splash pattern.
(2) The OCE has contact with the tow aircraft, target, and firing aircraft either on the radar scope or visually.
(3) The RIO has transmitted RENO and JUDY.

g. SKIP IT shall be transmitted: NEW

(1) By the OCE when the firing airplane is at minimum range to the target or approaching the tow aircraft safety arc.
(2) At any time, by anyone, if safety considerations warrant.
(3) By the OCE if he has visual contact of the target and cannot confirm HOTSHOT.
(4) If the firing aircrew elects to abort the run for any reason, either the pilot or RIO will transmit SKIP IT.

h. If the missile fails to fire, the firing pilot will transmit HUNG MISSILE. The OCE will remind the pilot to DE-ARM. Local ordnance safety procedures should then be observed.

(U) AIM-9D/G PROCEDURES

(U) Launch and safety parameters for the AIM-9D/G are not available.

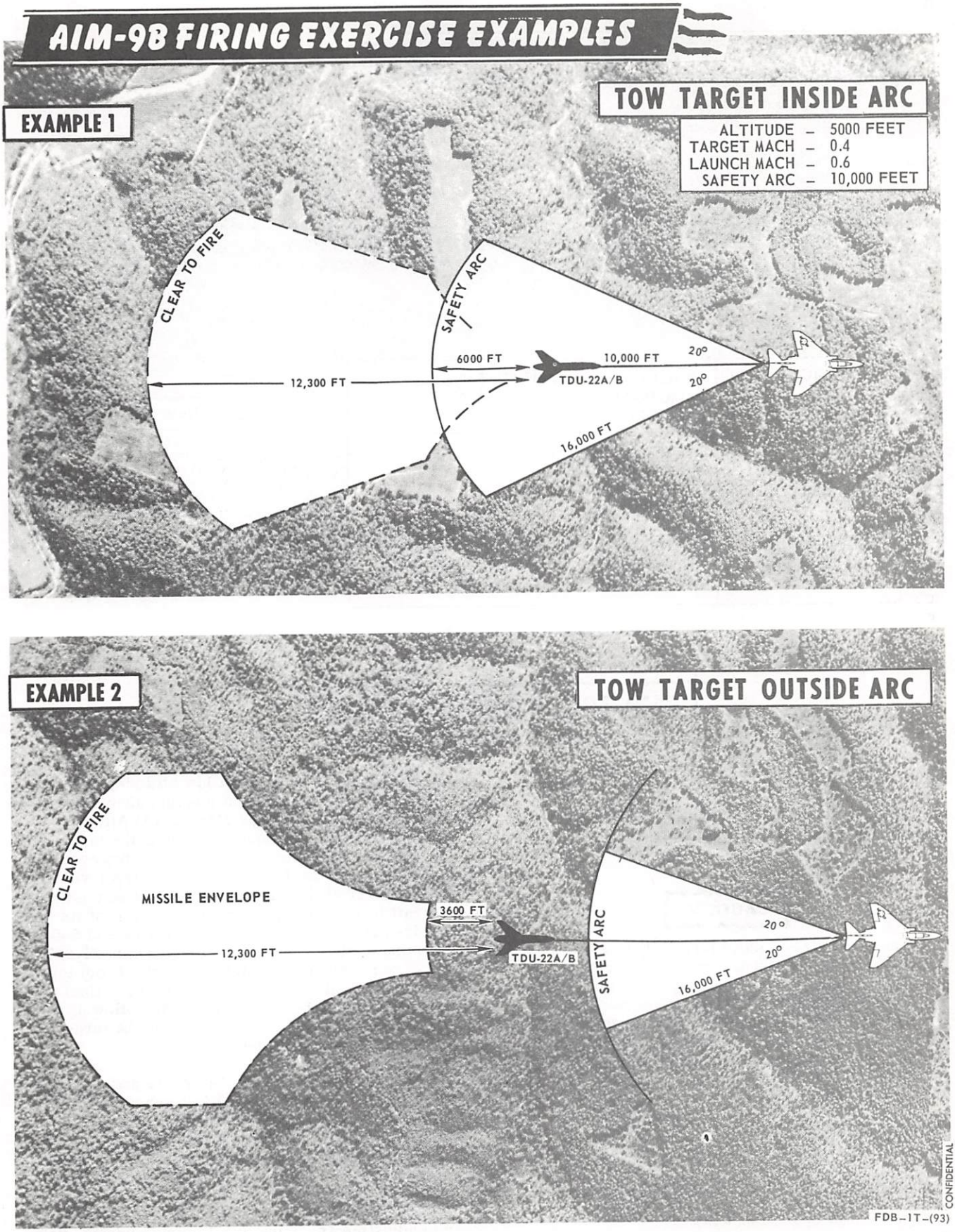
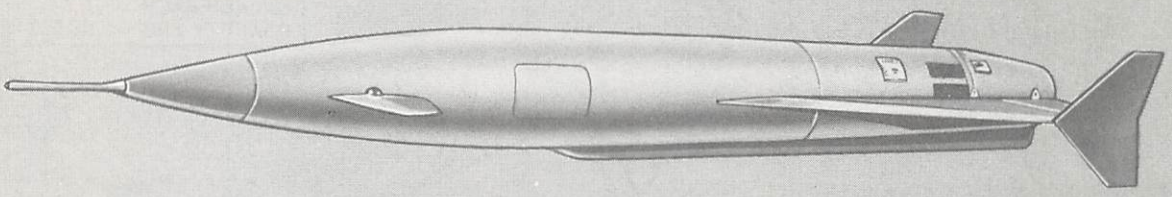

AIM-9B FIRING EXERCISE EXAMPLES
EXAMPLE 1
TOW TARGET INSIDE ARC
ALTITUDE – 5000 FEET
TARGET MACH – 0.4
LAUNCH MACH – 0.6
SAFETY ARC – 10,000 FEET
CLEAR TO FIRE
SAFETY ARC
6000 FT
10,000 FT
20°
12,300 FT
TDU-22A/B
20°
16,000 FT
EXAMPLE 2
TOW TARGET OUTSIDE ARC
CLEAR TO FIRE
MISSILE ENVELOPE
3600 FT
12,300 FT
TDU-22A/B
SAFETY ARC
20°
20°
16,000 FT
CONFIDENTIAL
FDB-1T-(93)

Figure 1-84 (C)

AQM-37A MISSILE TARGET



DIMENSIONS:	LENGTH . . . . . 13 FT. 6 IN. WINGSPAN. . . . . 3 FT. 4 IN. DIAMETER . . . . . 1 FT. 1 IN.
ALTITUDE:	MINIMUM - 1000 FT. MAXIMUM - 70,000 FT.
SPEED:	0.9 TO 2.0 MACH
AUGMENTATION:	CONTROL AND STABILIZATION SYSTEM, C AND X BAND TWT, INFRARED FLARES, AND AERODYNAMIC DESTRUCT SYSTEM.

Note

REFER TO NAVAIR 01-245FDB-1 OR NAVAIR 01-245FDD-1 (NATOPS FLIGHT MANUALS) AND AQM-37 OPERATIONAL MISSION PLANNING GUIDE, NAVAIR 01-90TBA-1T, FOR PREFLIGHT AND MISSION PROFILE/ OPERATING PROCEDURES FOR THIS TARGET.

CONFIDENTIAL

FDB-1T-(94)

Figure 1-85 (C)

AIR-TO-AIR MISSILE TARGETS

(U) POWERED TARGETS

(U) See figures 1-85 thru 1-88 for type of powered targets and their leading particulars.

CAUTION

The small size of these targets can cause large errors in visual range estimation. A direct hit can result in an explosion and fragmentation. The high deceleration rates of the resultant debris will cause phenomenal increases in the closing velocity with the firing aircraft and increase the possibility of aircraft to debris collision.

(U) TOWED TARGETS

(U) See figure 1-89 for leading particulars.

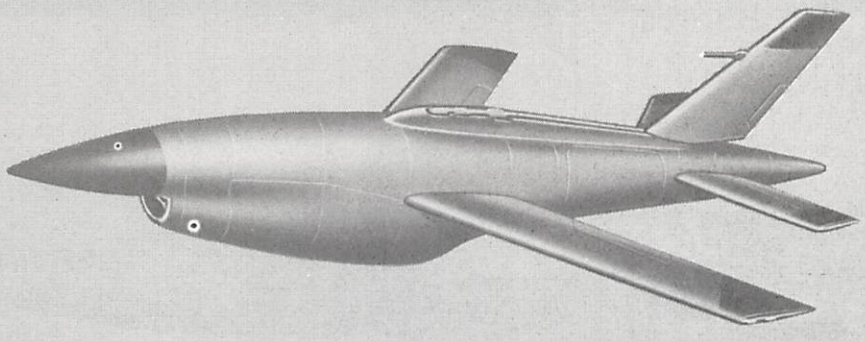
(U) Low Altitude Towing Operations

(U) For towing operations at low altitude, the target is launched and streamed at medium altitude as described in NATOPS Flight Manual NAVAIR 01-245FDB-1. The technique for placing the target at low altitude (stepping down) is simple; however, the maneuver must not be hurried. The target will lag the tow aircraft during the descent and as the tow aircraft levels off, the target will overshoot its final steady-state altitude. With a descent rate of 500 feet per minute, the overshoot of the target on 21,000 feet of wire is approximately 400 feet. From this, it can be seen that a very gradual descent to final towing altitude must be maintained. The following technique is recommended for positioning the target at altitudes as low as 100 feet:

a. Descend to 2500 feet at 240 KCAS and at a maximum rate-of-descent of 1000 feet per minute. The descent should be made on a heading as near as possible to the final presentation heading.

b. Fly straight and level for 1 minute at 2500 feet, increasing speed slowly to final target presentation speed, and carefully observing tow wire breaking strength limit speed. Make the final heading and trim adjustments during this 1-minute period, using no more than 10° of bank.

BQM-34A MISSILE TARGET



DIMENSIONS:	LENGTH .....23 FEET WINGSPAN .....12 FEET 11 INCHES HEIGHT.....6 FEET 8 INCHES
RADAR REFLECTIVITY UNAUGMENTED:	HEAD-ON-ONE SQUARE METER BEAM - FOUR SQUARE METERS
ALTITUDE:	MINIMUM - 200 FEET MAXIMUM - 50,000 FEET
SPEED:	10,000 FEET - 600 KNOTS 50,000 FEET - 550 KNOTS
TIME ON STATION:	50,000 FEET, 500 KNOTS - 86 MINUTES
AUGMENTATION:	S-BAND BEACON, TELEMETRY TRANSMITTING SET STANDARD EQUIPMENT. CAN BE AUGMENTED WITH L, C, X BAND BEACONS, TWT, INFRARED FLARES, SMOKE, CAMERAS, SCORING DEVICES, AND COUNTERMEASURES.

CONFIDENTIAL

FDB-1T-(95)

Figure 1-86 (C)

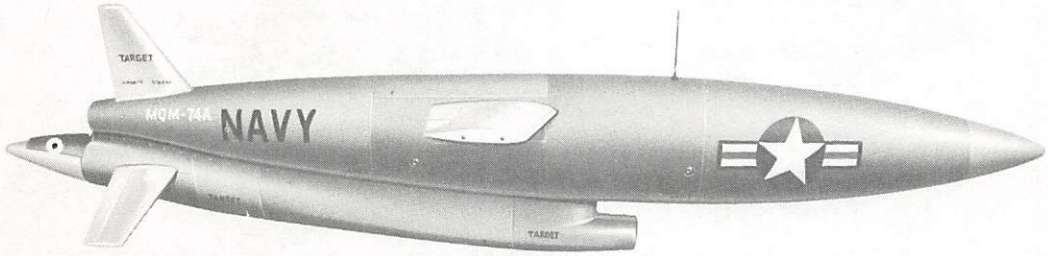
c. Maintain target presentation speed while descending at 500 feet per minute to 2000 feet, and at 200 feet per minute to 1700 feet. Use the radar altimeter for altitude indication and maintain the target presentation speed during the descent. The target stabilizes between 100 and 200 feet. Small turns, with no more than 5° of bank, can be made after leveling at 1700 feet.

d. The last few feet of descent should be made on instruments, using gentle high dips to ease the target to the desired altitude.

Note

A good rule of thumb to remember is that each 5 knots of airspeed is worth 25 feet of altitude. If you slow down, the target goes down.

MQM-74A MISSILE TARGET



MQM–74A RECOVERABLE, RADIO–CONTROLLED, JET–POWERED MISSILE TARGET

LENGTH	12 FEET 9 INCHES.
WING SPAN	5 FEET 6 INCHES.
HEIGHT	2 FEET 3 INCHES.
GROSS WEIGHT	408 POUNDS MAXIMUM AT LAUNCH.
POWERPLANT	WR–24–6 TURBOJET.
ALTITUDE	200 TO 20,000 FEET.
SPEED	200 TO 400 KNOTS.
TIME ON STATION	24 MINUTES AT 400 KNOTS AT 500 FEET. 34 MINUTES AT 400 KNOTS AT 20,000 FEET. 52 MINUTES AT 200 KNOTS AT 500 FEET. 74 MINUTES AT 200 KNOTS AT 20,000 FEET.
LAUNCH	TWO MK 34 MOD 1 ROCKET BOOSTERS.
RECOVERY	PARACHUTE SINK RATE 20 FEET PER SECOND.
CONTROL	UHF RADIO COMMAND–CONTROL LINK FROM PORTABLE GROUND OR SHIPBOARD STATION.
AUGMENTATION	INSTALLATION PROVISIONS FOR: BISTATIC LUNEBERG LENS (FWD). MONOSTATIC LUNEBERG LENS (AFT) VISUAL SMOKE. CONTRACTURAL PROVISIONS FOR: L–BAND BEACON (APX–71). IR FLARES (MK 37 MOD 0).
SCORING	MDI (PROVISIONS FOR).
ECM	NONE.

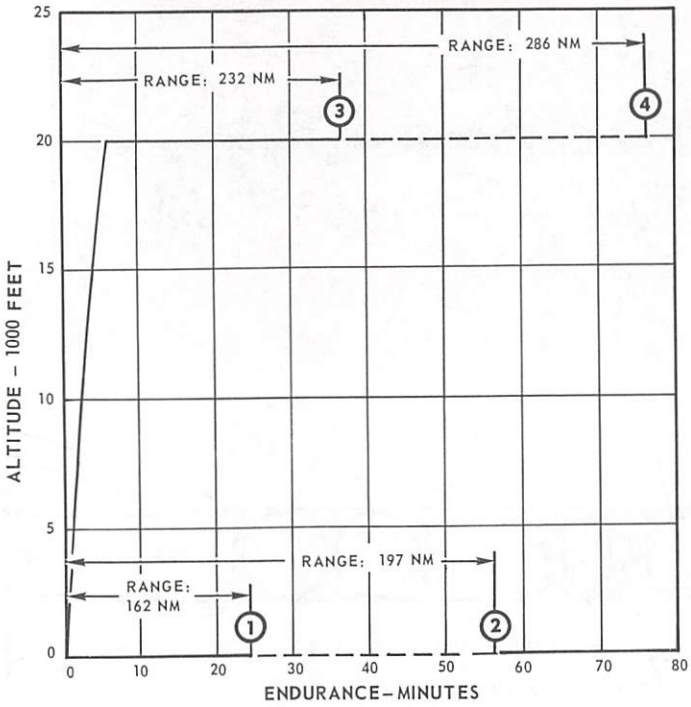
CONFIDENTIAL

FDB–1T–(220)

Figure 1-87 (C)

MQM-74A PERFORMANCE

TYPICAL MISSION PERFORMANCE



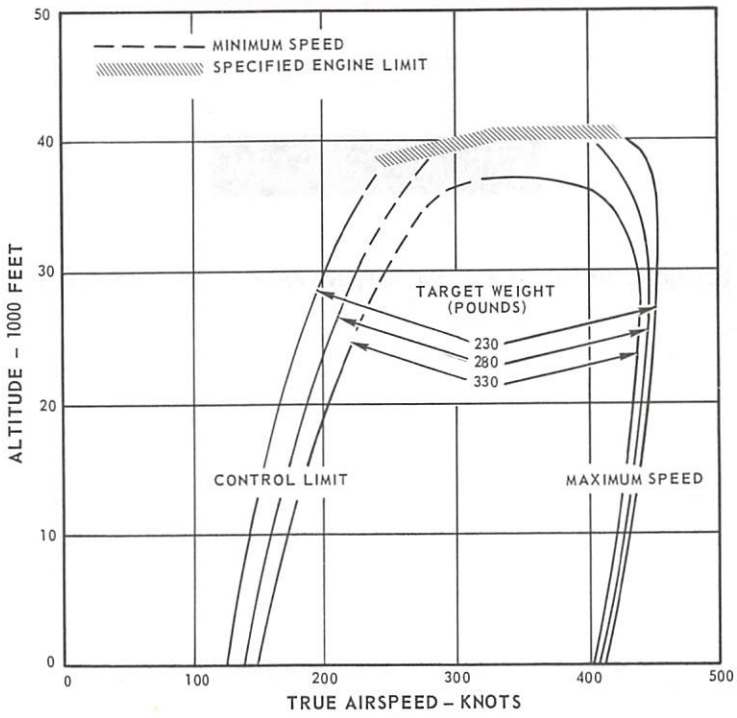
① SEA-LEVEL SPEED RUN

② SEA-LEVEL CRUISE AT 210 KNOTS (TAS)

③ 20,000-FOOT - ALTITUDE SPEED RUN

④ 20,000-FOOT - ALTITUDE CRUISE AT 220 KNOTS (IAS)

ESTIMATED SPEED PERFORMANCE



CONFIDENTIAL

FDB-17-(219)

Figure 1-88 (C)

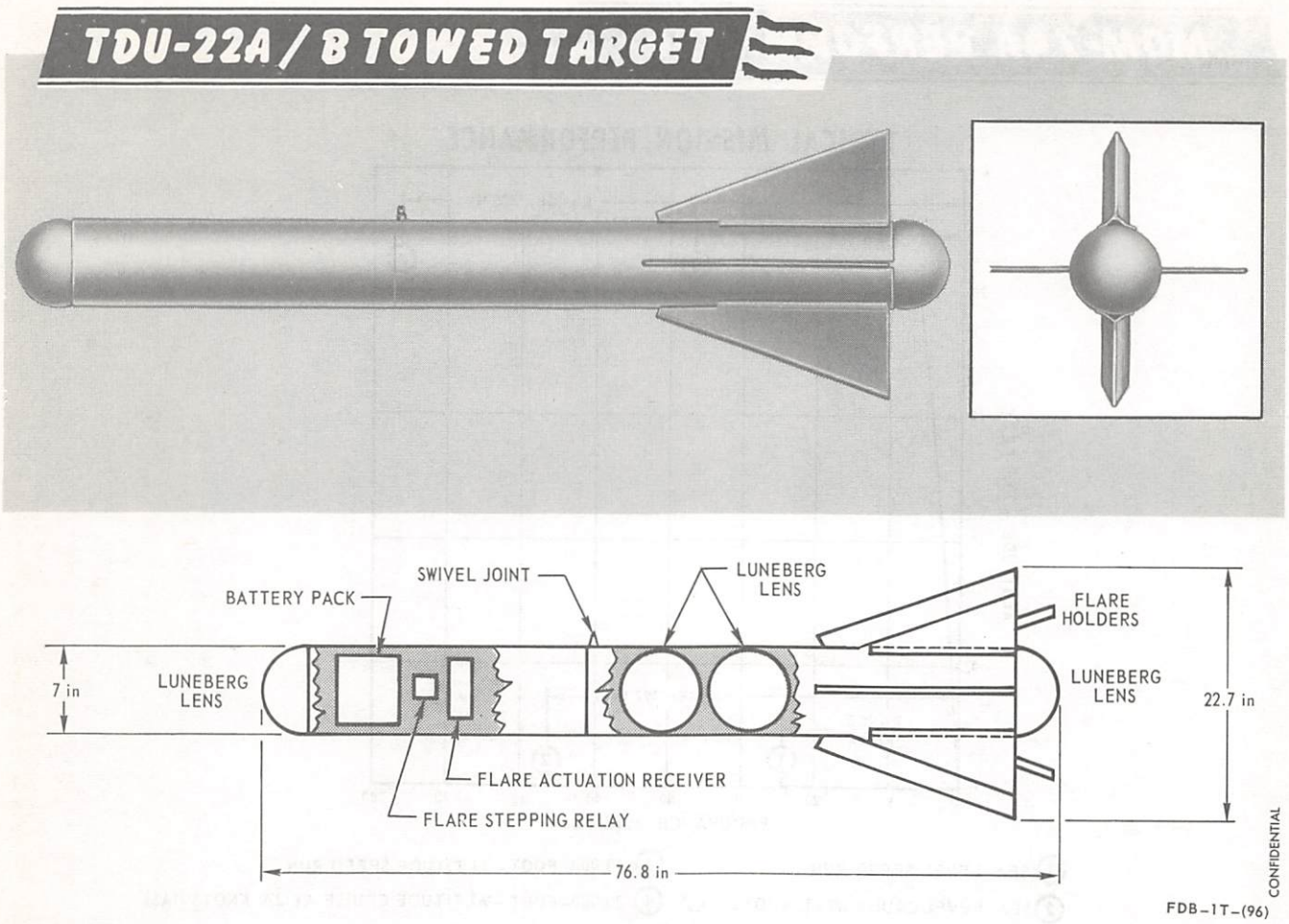


Figure 1-89 (C)

PART 8 ECM/ECCM

(U) Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A).

SECTION II

CONVENTIONAL AIR-TO-GROUND WARFARE

TABLE OF CONTENTS

	Page No.
PART 1. GENERAL	2-1
Multiple Weapons Release System	2-3
Gunnery Equipment	2-15
CONLABS Release System	2-18
Jettison System	2-23
Suspension Equipment	2-29
Weapon Selection	2-36
Fuzing and Fuze Limitations	2-37
Bomb/Fuze Combinations	2-38
Minimum Authorized Arming Times and Speeds	2-45
MK 347 Nose Fuse	2-47
M904 E2/E3/E4 Nose Fuze	2-48
M1A1 Fuze Extension (Daisy Cutter)	2-49
MK 36/40 Destructor (DST) Arming and Firing System	2-50
M918 Multi-position Fuze	2-53
MK 13 Mod 0 Fire Bomb Initiator	2-54
MK 344/376 Tail Fuze	2-55
M990E-1/E-3/E-4 Tail Fuzes	2-57
MK 346 Fuze	2-59
M907 E1/E2 Fuze	2-61
MK 339 Mod 0 Fuze	2-62
M20/20A1 Sensing Element	2-64
MK 43 Target Detecting Device	2-67
Rocket Fuze Compatability & Application	2-70
Rocket Fuzes	2-71
Rocket Warheads	2-73
Rocket Motors	2-77
References	2-77
Navigation	2-79
PART 2. MISSIONS	2-86
Mission Planning Index	2-86
Preplanned Strikes	2-86
Armed Reconnaissance	2-95
Close Air Support	2-96
Special Missions	2-101
General	2-101
Rescap	2-101
Helicopter Escort	2-101
AN/TPQ-10 Ground Controlled Radar Bombing	2-102
Night Attack	2-104
Laser Mission	2-115
PART 3. DELIVERY MANEUVERS	2-120
Safe Escape Conditions	2-120
Bombing/Rocketry	2-124
Dive Delivery Considerations	2-125
Level Delivery Considerations	2-133
Multiple Release Considerations	2-135
Rocketry	2-136
Fire Bomb Delivery	2-136
Cluster Bomb Delivery	2-136
Destructor Delivery	2-138
Strafing	2-138
CONLABS Delivery	2-142
PART 4. WEAPON DELIVERY DATA	2-145
BORESIGHTING	2-145
CHART DESCRIPTION	2-146
DELIVERY DATA DESCRIPTION	2-150
SAMPLE PROBLEMS AND COMPUTATIONS	2-154
AIRSPEED CONVERSION CHART	2-161
FUSELAGE ANGLE OF ATTACK CHART	2-164
ALTIMETER LAG CHARTS	2-165
SIGHT ANGLE CORRECTIONS CHART	2-166
DIVE RECOVERY CHART	2-167
DIVE ACCELERATION CHARTS	2-170
DIVE ANGLE/HORIZONTAL DISTANCE	2-173
AIRCRAFT DOWN RANGE TRAVEL AND ALTITUDE LOSS CHARTS	2-174
STRAFING DOWN RANGE TRAVEL AND ALTITUDE LOSS CHARTS	2-177
M117A1 GP BOMB (750 LB)	2-179
Maximum Fragment Envelope	2-180
Release Error Sensitivities & Wind Correction	2-180
Sight Angle	2-181
Bomb Spacing	2-185
MK 81 SNAKEYE BOMB (250 LB)	2-186
Maximum Fragment Envelope	2-187
RETARDED DELIVERY DATA:	
Release Error Sensitivities & Wind Correction	2-187
Sight Angle	2-188
Bomb Spacing	2-192
UNRETARDED DELIVERY DATA:	
Release Error Sensitivities & Wind Correction	2-193
Sight Angle	2-194
Bomb Spacing	2-198
MK 82 SNAKEYE BOMB (500 LB)	2-199
MK 36 DESTRUCTOR (500 LB)	2-200
MK 124 PRACTICE BOMB (500 LB)	2-201
Maximum Fragment Envelope	2-202
RETARDED DELIVERY DATA (MK 82/36/124 SNAKEYE FIN):	
Release Error Sensitivities & Wind Correction	2-202
Sight Angle	2-203
Bomb Spacing	2-207
UNRETARDED DELIVERY DATA (MK 82/36/124 SNAKEYE FIN):	
Release Error Sensitivities & Wind Correction	2-208
Sight Angle	2-209
Bomb Spacing	2-213
MK 40 DESTRUCTOR (1000 LB)	2-214
Release Error Sensitivities & Wind Correction	2-215
RETARDED DELIVERY DATA (SNAKEYE FIN):	
Maximum Fragment Envelope	2-216
Sight Angle	2-217
Bomb Spacing	2-221

	Page No.
UNRETARDED DELIVERY DATA (SNAKEYE FIN):	
Release Error Sensitivities & Wind Correction	2-222
Sight Angle	2-223
Bomb Spacing	2-227
MK 81 LDGP BOMB (250 LB)	2-228
MK 86 PRACTICE BOMB (250 LB)	2-229
Maximum Fragment Envelope	2-230
DELIVERY DATA (MK 81/86 CONICAL FIN):	
Release Error Sensitivities & Wind Correction	2-230
Sight Angle	2-231
Bomb Spacing	2-235
MK 82 LDGP BOMB (500 LB)	2-236
MK 87 PRACTICE BOMB (500 LB)	2-237
Maximum Fragment Envelope	2-238
DELIVERY DATA (MK 82/36/87/124 CONICAL FIN):	
Release Error Sensitivities & Wind Correction	2-238
Sight Angle	2-239
Bomb Spacing	2-243
MK 83 LDGP BOMB (1000 LB)	2-244
MK 88 PRACTICE BOMB (1000 LB)	2-245
Maximum Fragment Envelope	2-246
DELIVERY DATA (MK 83/40/88 CONICAL FIN):	
Release Error Sensitivities & Wind Correction	2-246
Sight Angle	2-247
Bomb Spacing	2-251
MK 82 LASER GUIDED BOMB	2-252
Maximum Fragment Envelope	2-253
Sight Angle	2-254
MK 77 MOD 4 FIRE BOMB (500 LB)	2-256
Release Error Sensitivities & Wind Correction	2-257
Sight Angle	2-258
Bomb Spacing	2-260
MK 76 PRACTICE BOMB (25 LB)	2-261
Release Error Sensitivities & Wind Correction	2-262
Sight Angle	2-263
Bomb Spacing	2-267
MK 106 PRACTICE BOMB (5 LB)	2-269
Release Error Sensitivities & Wind Correction	2-270
Sight Angle	2-271
Bomb Spacing	2-273
MK 89 PRACTICE BOMB (56 LB)	2-275
Release Error Sensitivities & Wind Correction	2-276
Sight Angle	2-277
Bomb Spacing	2-281
ROCKET LAUNCHER COMPARISONS	2-282
AERO 7D, LAU-3A/A, -60/A, -61/A, -69/A ROCKET LAUNCHERS	2-283
LAU-32A/A, -32B/A, -56/A, -68/A ROCKET LAUNCHER	2-284
2.75-INCH FFAR DELIVERY DATA:	
Maximum Fragment Envelope	2-285
Release Error Sensitivities & Wind Correction	2-287
Sight Angle (MK 1 & MK 5 Warheads)	2-288
Sight Angle (M151 Warhead)	2-292
LAU-10A/A ROCKET LAUNCHER	2-296
LAU-33A/A ROCKET LAUNCHER	2-297
5.0-INCH ZUNI DELIVERY DATA:	
Maximum Fragment Envelope	2-298
Release Error Sensitivities & Wind Correction	2-301
Sight Angle	2-302
ZUNI MK 33 FLARE DELIVERY DATA:	
Sight Angle	2-306
Flare Spacing	2-307
Down Range Travel	2-308
CBU-24, -29, -49 DISPENSERS	2-309
Release Error Sensitivities & Wind Correction	2-310
Sight Angle	2-311
Pattern and Arming	2-319
Typical CBU-24/B Bomblet Patterns	2-325
Bomb Spacing	2-328
ROCKEYE II (MK 20 MOD 2 & 3)	2-331
Release Error Sensitivities & Wind Correction	2-334
Sight Angle (1.2 Sec.)	2-335
Sight Angle (4.0 Sec.)	2-339
Impact Pattern (1.2 Sec.)	2-343
Impact Pattern (4.0 Sec.)	2-346
Bomb Spacing (1.2 Sec.)	2-349
Bomb Spacing (4.0 Sec.)	2-350
MK 4 MOD 0 GUN POD	2-351
20MM AMMUNITION	2-352
Release Error Sensitivities & Wind Correction (Parallel to FRL)	2-353
Sight Angle (Parallel to FRL)	2-354
Release Error Sensitivities & Wind Correction (2° Below FRL)	2-358
Sight Angle (2° Below FRL)	2-359
SUU-40/A & -44/A FLARE DISPENSER	2-363
MK 24 PARAFLARE	2-364
Delivery Data	2-366
MK 45 PARAFLARE	2-368
Delivery Data	2-370
CTU-1A DELIVERY CONTAINER	2-372
MK 12 MOD 0 SMOKE TANK	2-373
CONLABS PULLUP-TO-IMPACT DIST	2-376
CONLABS WIND OFFSET COMPONENTS	2-383
CONLABS CORRECTIONS	2-384

PART 1 GENERAL

MULTIPLE WEAPONS RELEASE SYSTEM

(U) DESCRIPTION

(U) In aircraft 150406L and up, and all other aircraft after AFC 78 (Part 1) the multiple weapons release system provides a conventional bomb and rocket delivery capability. The system is comprised of an optical sight unit, a multiple weapons control panel, a bomb release (pickle) button, a fuze function control set, two wing missile pylons (LAU-17-inboard), two wing tank pylons (outboard), a centerline bomb rack (Aero 27A), and the appropriate multiple bomb racks and pylon adapters. Refer to External Stores Limitations chart, appendix A, for authorized stores and load configurations. Figure 2-1 illustrates the Multiple Weapons Controls and Indicator. Refer to figure 2-2 for Multiple Weapons Station Sequencing and to figure 2-3 for Normal Release Sequencing.

(U) AUXILLIARY ARMAMENT CONTROL PANEL

(U) Refer to Gunnery Equipment.

(U) ARMAMENT SAFETY OVERRIDE BUTTON

(U) The armament safety override button is used by the ground crew to check out the normal bomb release circuit. The safety switch in the landing gear handle is bypassed when the armament safety override button is depressed in order to supply power to the following armament bus circuit breakers.

NEW (U) F-4B/N 148363f thru 152994y armament bus circuit breakers:

a. Radar Missile, F9 No. 1 panel.
b. CL Stores Release Control, H11 No. 1 panel.
c. Bomb & Rocket Release Control, D1 No. 2 panel.
d. AN/AWW-1 Bomb Fuzing, D5 No. 2 panel.
e. AN/ALE-29, C5 Shoehorn cb panel.

NEW (U) F-4B/N 152995z and up armament bus circuit breakers:

a. Weapon Release Cont, H11 No. 1 panel.
b. Radar Missile, F9 No. 1 panel.
c. Bomb & Rocket Release Control, D1 No. 2 panel.
d. AN/AWW-1 Bomb Fuzing, D5 No. 2 panel.
e. AN/ALE-29, C5 Shoehorn cb panel.

(U) F-4J 153071z thru 153088aa, also 153768ab thru 155528ag before AFC 388 armament bus circuit breakers:

a. Stores Release Control, E5 No. 1 panel.
b. Missile Firing, E6 No. 1 panel.
c. Bomb & Rkt Rel Cont, E4 No. 2 panel.
d. AN/AWW-1 Bomb Fuzing, D7 No. 2 panel.

(U) F-4J 155529ag and up, also 153768ab thru 155528ag after AFC 388 armament bus circuit breakers:

a. Stores Release Control, A10 No. 1 panel.
b. Missile Firing, A9 No. 1 panel.
c. Bomb &Rkt Rel Cont., G5 No. 2 panel.
d. AN/AWW-1 Bomb Fuzing, E7 No. 2 panel.
e. Shoehorn, All No. 1 panel.

WARNING

If the armament safety override button is IN with the landing gear handle down and electrical power is applied to the aircraft, the landing gear handle armament release safety feature is bypassed and 28 volt dc power is supplied to the armament bus relay. Subsequent closing of switches downstream in the circuit could result in inadvertent releasing and or firing of ordnance while the aircraft is on the ground.

Note

The armament safety override button does not bypass the left main landing gear scissors switch, which interrupts operation of the EXTERNAL STORES EMERGENCY RELEASE BUTTON (panic button) until weight is off the gear. Refer to Jettison System, this part.

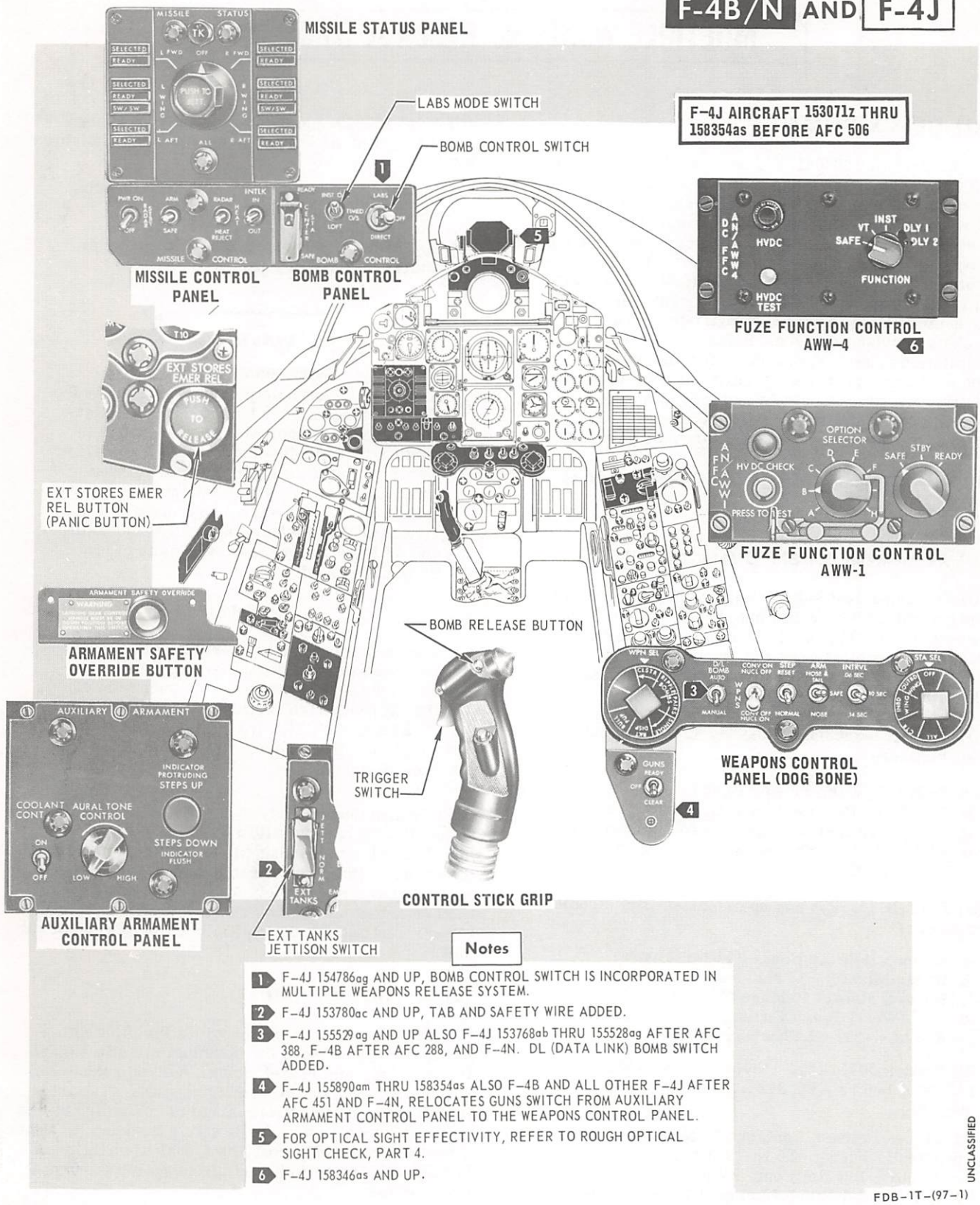
(U) The armament safety override button (figure 2-1) under the left canopy sill in the front cockpit is primarily used for checking out the bombing circuits on the ground. However, it can be used to bypass the landing gear handle safety switch to provide power to the armament bus for the centerline jettison circuit (figure 2-7) and for the multiple weapons release circuit.

(U) OPTICAL SIGHT UNIT

(U) The optical sight unit provides the pilot with a visual sight reference for bombing, missile launching, strafing, and rocket firing. A fixed reticle image is projected on the combining glass. The intensity (brightness) of the reticle image is controlled by the reticle illumination knob. Rotating the knob, in either direction from OFF, controls a dual filament reticle lamp which projects the reticle image on the combining glass.

MULTIPLE WEAPONS CONTROLS AND INDICATORS

F-4B/N AND F-4J



Notes

1. F-4J 154786ag AND UP, BOMB CONTROL SWITCH IS INCORPORATED IN MULTIPLE WEAPONS RELEASE SYSTEM.
2. F-4J 153780ac AND UP, TAB AND SAFETY WIRE ADDED.
3. F-4J 155529ag AND UP ALSO F-4J 153768ab THRU 155528ag AFTER AFC 388, F-4B AFTER AFC 288, AND F-4N. DL (DATA LINK) BOMB SWITCH ADDED.
4. F-4J 155890am THRU 158354as ALSO F-4B AND ALL OTHER F-4J AFTER AFC 451 AND F-4N, RELOCATES GUNS SWITCH FROM AUXILIARY ARMAMENT CONTROL PANEL TO THE WEAPONS CONTROL PANEL.
5. FOR OPTICAL SIGHT EFFECTIVITY, REFER TO ROUGH OPTICAL SIGHT CHECK, PART 4.
6. F-4J 158346as AND UP.

UNCLASSIFIED

FDB-1T-(97-1)

Figure 2-1 (U) (Sheet 1 of 2)

MULTIPLE WEAPONS CONTROLS AND INDICATORS (CONTINUED)

F-4J

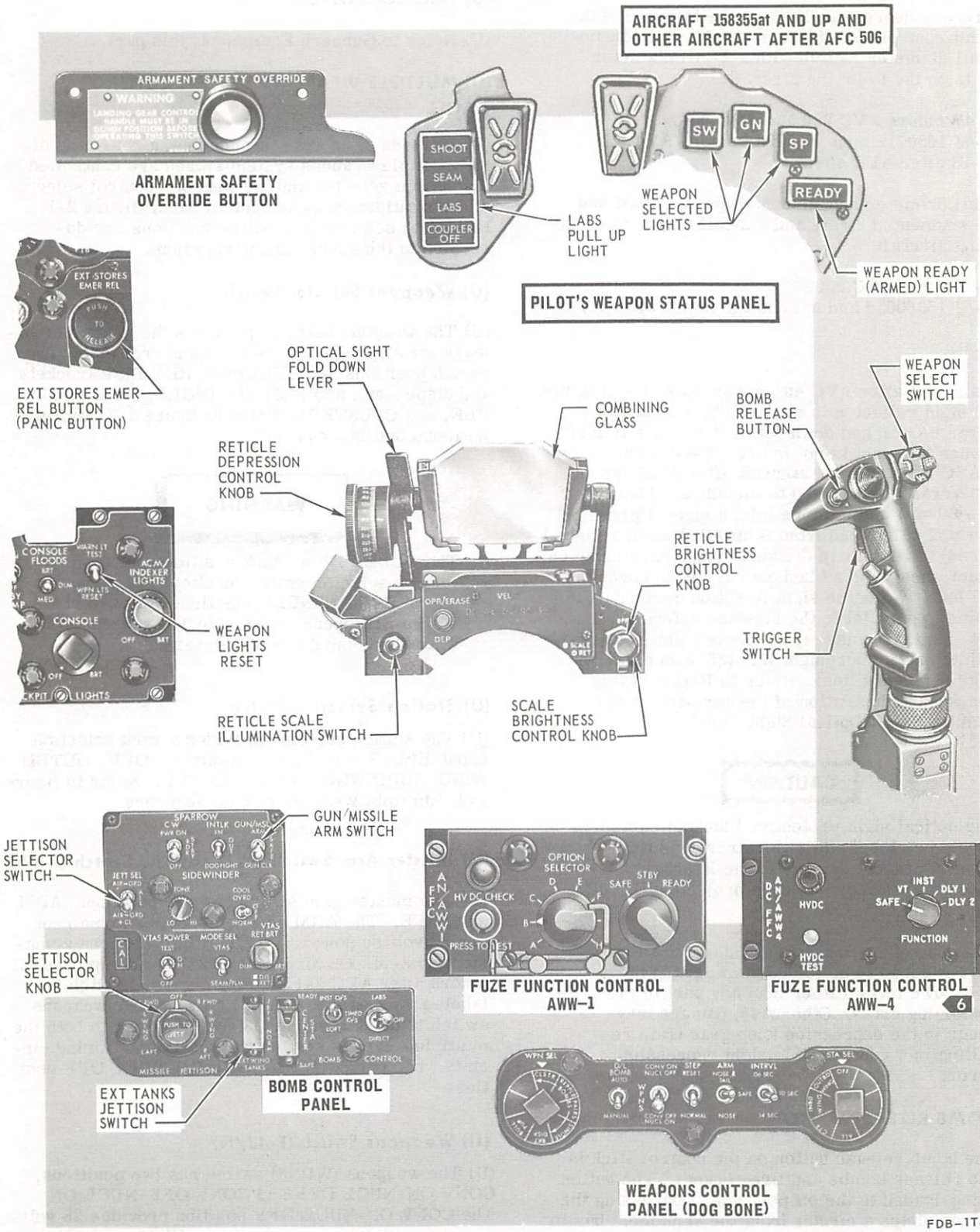


Figure 2-1 (U) (Sheet 2 of 2)

Note

The bottom filament should be used first. The bottom filament is selected by rotating the reticle illumination knob counterclockwise.

(U) A reticle depression knob on the left side of the sight unit controls the depression of the reticle image. A 50-mil diameter reticle with a 2-mil diameter pipper is on the following aircraft:

a. F-4B before AVC 290 and AVC 464.
b. F-4J 153071z thru 153799ac before AVC 498.
c. F-4B after AVC 464.

A 60-mil diameter reticle containing a 40-mil and 20-mil segmented circle and a 2-mil pipper is on the following aircraft:

a. F-4B after AVC 290.
b. F-4J 153800ad and up, and all others after AVC 498.
c. F-4N.

F-4B aircraft after AVC 464 (modified A-1 sight), the optical sight reflector is replaced by a reflector which can be cranked down out of the pilot's line of sight when the sight is not in use. F-4B aircraft after AVC 290 and F-4J aircraft after AVC 498 and F-4N aircraft are changed to include a fold-down sight, a 60-mil diameter reticle, a sight depression drum wheel calibrated from 0 thru 280 mils, a night light (red) to illuminate the sight depression scale on the drum wheel, and a blackout curtain to cover the optical lens. When the sight is set on zero mils, the sight line is parallel to the fuselage reference line. The SW position is used to align the sight line parallel with the radar boresight line (35 mils below the fuselage reference line). Refer to Part 4 of this section for an illustration of the various optical sight units, Rough Optical Sight Check.

CAUTION

- The optical sight protective blackout curtain should be closed while the aircraft is tied down to prevent damage to the internal components caused by sun rays projecting through the collimating lens.
- When the sight combining glass on the F-4J/N MAC sight is to be folded down, grasp the fold-down lever rather than any part of the combining glass. Otherwise, damage may occur in the depression knob gear train resulting in a considerable sight depression error.

(U) BOMB RELEASE BUTTON

(U) The bomb release button on the control stick is used to release bombs and fire rockets. The button is spring-loaded to the off position. Depressing the button completes a circuit from the armament bus to the bomb button transfer relay. This relay then directs voltage to either the centerline nuclear weapons release circuit or multiple weapon release circuit, depending on the position of the weapons switch: CONV OFF - NUCL ON or CONV ON - NUCL OFF, respectively.

(U) TRIGGER SWITCH

(U) Refer to Gunnery Equipment, this part.

(U) MULTIPLE WEAPONS SYSTEM CONTROL PANEL

(U) Methods of release, sequencing, and arming of the multiple weapons system stores are controlled by the station selector and the weapons control selector of the multiple weapons control panel (figure 2-1). Individual selector and switch functions are described in the succeeding paragraphs.

(U) Weapons Selector Switch

(U) The weapons selector provides the method of release for all types of air-to-ground ordnance. The switch positions are BULLPUP, RKT DISP (rockets and dispenser), and BOMBS (SINGLE, PAIRS, RIPPLE, and CLUSTER). Refer to figure 2-2, Multiple Weapons Station Sequence.

WARNING

The BULLPUP or blank positions on the weapon selector switch functions the same as the BOMB/SINGLE position. Release of stores will occur on the selected station when the bomb button is depressed.

(U) Station Selector Switch

(U) The station selector provides a rack selection capability. The switch positions are OFF, OUTBD WING, INBD WING, CTR, and ALL. Refer to figure 2-2, Multiple Weapons Station Sequence.

(U) Master Arm Switch or Weapons Switch (F-4B)

(U) The master arm switch has two positions, ARM and SAFE. The ARM position supplies armament bus 28 volt dc power to the multiple weapons armament system. On airplanes 152278w and up, and all others after AFC 241, the master arm switch is labeled the weapons (WPNS) switch. The weapons switch is used to supply 28 volt dc power to both the multiple weapons system and the gun pod firing circuits when placed in the CONV ON-NUCL OFF position.

(U) Weapons Switch (F-4J/N)

(U) The weapons (WPNS) switch has two positions, CONV ON-NUCL OFF and CONV OFF-NUCL ON. The CONV ON-NUCL OFF position provides 28 volts dc armament bus power to the multiple weapons system and the gun pod firing circuits.

MULTIPLE WEAPONS STATION SEQUENCE

WEAPONS SELECTOR SWITCH POSITION– *SINGLE*

STATION SELECTOR SWITCH POSITION			
OUTBOARD	**INBOARD**	**CENTERLINE**	**ALL**
The bombs are released one at a time from the outboard wing station MER/TER alternately from one station and then the other–the left station will always receive the first firing signal after reset. One bomb is released for each actuation of the bomb release button until both the outboard racks are empty.	Same as outboard.	The bombs are released one at a time from the centerline station multiple weapons rack. Before Cable No. 32G94729, one bomb is released for each actuation of the bomb release button. After IAAC 558, recommend PAIRS release mode be used. If the SINGLE release mode is used, the first bomb may be released with the first pickle or the second pickle depending on which wire was cut during the cable mod. After the first bomb release the bomb button must be depressed two times to obtain one bomb release.	The ALL position selects the outboard station until the station is empty. When the outboard station is empty the inboard stations are selected until empty, then the centerline station is selected. AAC 509 affects automatic station transfer, refer to Suspension Equipment, Normal Operation.

WEAPONS SELECTOR SWITCH POSITION– *PAIRS*

STATION SELECTOR SWITCH POSITION			
OUTBOARD	**INBOARD**	**CENTERLINE**	**ALL**
Two single pulses are supplied simultaneously to both the left and right outboard wing station multiple weapons bomb racks releasing a bomb from each. Each time the bomb release switch is depressed another pair of bombs is released until the racks are empty.	Same as outboard.	Before and after cable mod, (IAAC 558), one bomb is released each time the bomb button is depressed.	The ALL position selects the outboard station until the station is empty. When the outboard station is empty the inboard stations are selected until empty, then the centerline station is selected. AAC 509 affects automatic station transfer, refer to Suspension Equipment, Normal Operation.

WEAPONS SELECTOR SWITCH POSITION– *RIPPLE*

STATION SELECTOR SWITCH POSITION			
OUTBOARD	**INBOARD**	**CENTERLINE**	**ALL**
By holding the bomb release button in the depressed position an alternating pulse is supplied continuously – first to the left and then to the right outboard wing station bomb rack releasing a bomb from each. The rate at which the pulse is supplied is determined by the setting selected on the INTRVL switch. This sequence will continue as long as the bomb release button is held depressed or until the rack is empty. Releasing the button will stop the sequence. Depressing it again will restart the sequence from the point at which it was stopped.	Same as outboard.	Before cable mod, holding the bomb release button in the depressed position, supplies pulses to the centerline multiple weapons bomb rack releasing the bombs singularly at a rate selected by the INTRVL switch. After cable mod, (IAAC 558), the bomb release rate is double the rate selected by the INTRVL switch. The first bomb may be released when the bomb button is depressed or after a time delay equal to the INTRVL setting, depending on which wire was cut during the cable mod.	The ALL position selects the outboard station until the station is empty. When the outboard station is empty the inboard stations are selected until empty, then the centerline station is selected. AAC 509 affects automatic station transfer, refer to Suspension Equipment, Normal Operation.

UNCLASSIFIED

FDB-1T-(98-1)

Figure 2-2 (U) (Sheet 1 of 2)

WEAPONS SELECTOR SWITCH POSITION– *CLUSTER*

STATION SELECTOR SWITCH POSITION			
OUTBOARD	**INBOARD**	**CENTERLINE**	**ALL**
Holding the bomb release button depressed supplies a pulsating signal simultaneously to both outboard wing station bomb racks releasing a bomb from each. This pulse is repeated at a rate selected on the INTRVL switch for as long as the bomb release button is depressed or until the racks are empty. Releasing the bomb button stops the sequence. Depressing it again will restart the sequence from the point at which it was stopped.	Same as outboard.	Before and after centerline cable mod, (IAAC 558) holding the bomb release button depressed supplies continuous pulses to the centerline multiple weapons bomb rack, releasing the bombs singly at a rate selected by the INTRVL switch until the bomb rack is empty.	The ALL position selects the outboard station until the station is empty. When the outboard station is empty the inboard stations are selected until empty, then the centerline station is selected. AAC 509 affects automatic station transfer, refer to Suspension Equipment, Normal Operation.

WEAPONS SELECTOR SWITCH POSITION– *RKT DISP*

STATION SELECTOR SWITCH POSITION			
OUTBOARD	**INBOARD**	**CENTERLINE**	**ALL**
Rocket firing is accomplished by momentarily depressing the bomb release switch. This supplies a pulse to the center rack on the left outboard wing station. The bomb release switch must be held depressed for .2 sec. to insure that all rockets are fired from the AERO 7D (2.75 in. FFAR'S) rocket pack and .5 sec. for the LAU-10/A (5 in. FFAR'S). When the rocket pack has fired the bomb release switch must be released and depressed again to supply a firing pulse to the right outboard wing station. On airplanes 152305 and up, both outboard wing station rocket packs fire when the bomb release switch is depressed. Blank ejector stations are automatically stepped over and the next loaded station selected when the bomb release switch is released.	Same as outboard. Left wing station is fired first.	Same as outboard stations, except that a single centerline rocket pack is selected and fired each time the bomb release switch is depressed.	This position is not used. However rockets can be fired from the outboard wing stations same as for OUTBOARD position of the station selector switch. With new wire bundle assembly No. 32–94729, automatic station transfer to the INBOARD station and then to the CENTERLINE station is available.

UNCLASSIFIED

FDB–1T–(98–2)

Figure 2-2 (U) (Sheet 2 of 2)

Note

On F-4J 158355at and up, and all other F-4J aircraft after AFC 506, the weapons switch is not in the gun pod firing circuit.

(U) Data Link Bomb Switch

(U) This switch has two positions, AUTO and MANUAL. The switch must be in the AUTO position for data link bombing; however, manual releases can be made with either position selected. Refer to NAVAIR 01-245FDD-1A.

(U) Guns Switch

(U) Refer to Gunnery Equipment.

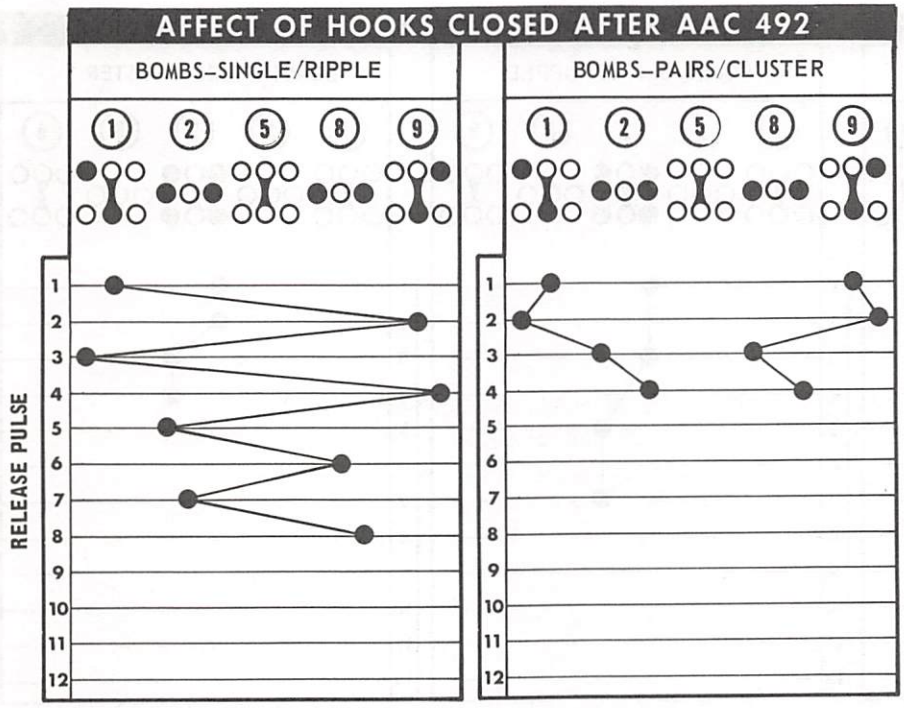
(U) Step Reset Switch

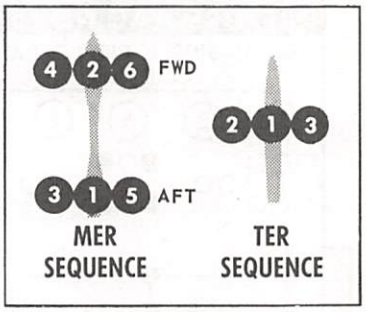
(U) The step reset switch has two positions; RESET and NORMAL. The switch is spring-loaded to NORMAL. When the switch is momentarily actuated to RESET, the intervalometer is reset to the left wing position. This switch will not step a release pulse over to the right side. Refer to Suspension Equipment (Normal Operation) for a description of the use of the step reset switch after AAC 509 to rehome the MER/TER racks.

(U) Bomb Arming Switch (Nose/Tail Arm Switch)

(U) The bomb arming switch is a toggle switch with three positions: NOSE & TAIL, SAFE, and NOSE. Selecting NOSE completes a circuit from the CONV ON-NUCL OFF position of the weapons switch to energize the nose arming solenoid in the bomb rack. Selecting NOSE & TAIL energizes both the nose and the tail arming solenoids in the bomb rack. The SAFE position removes power from the arming solenoids to permit mechanically armed bombs to be dropped in a safe condition. Refer to Fuzing section for a description of safe jettison.

NORMAL RELEASE SEQUENCE





TOP VIEW

* BEFORE AAC 558.
○ EMPTY, HOOKS OPEN.
⊗ EMPTY, HOOKS CLOSED AFTER AAC 492.
● LOADED.

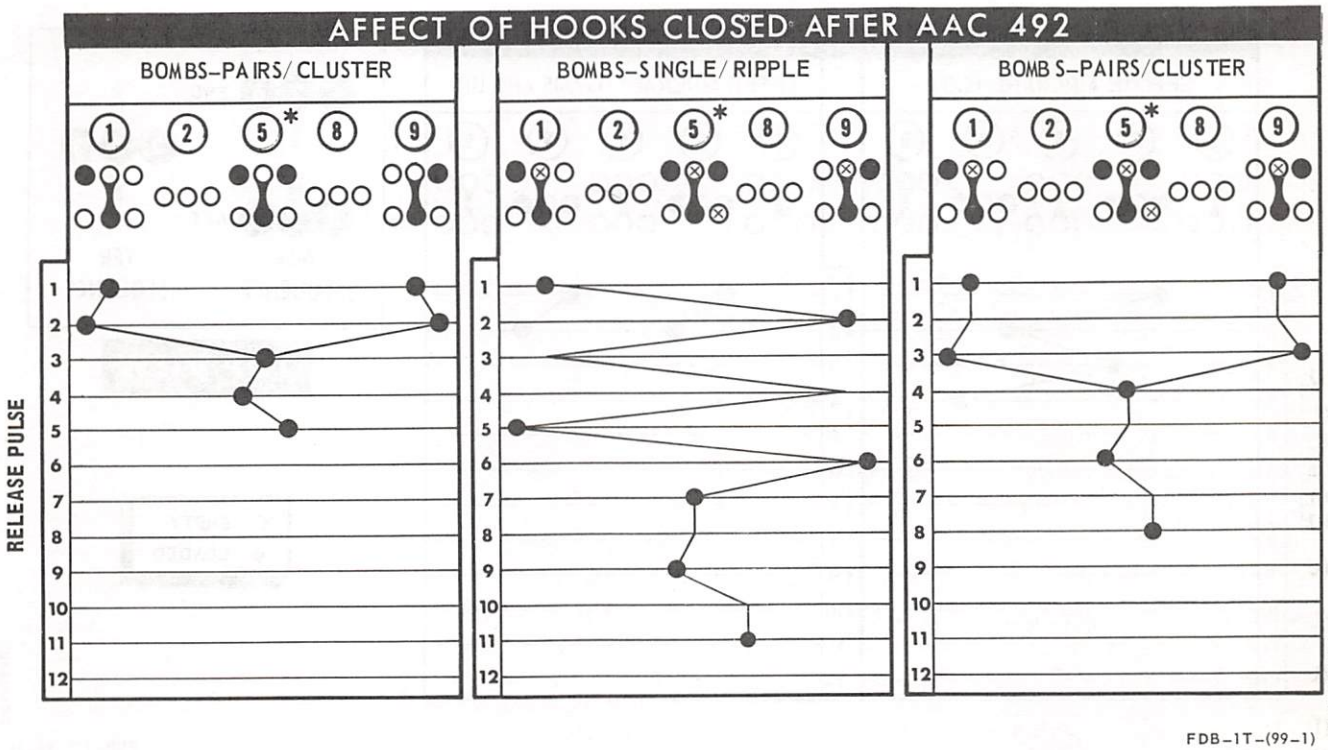
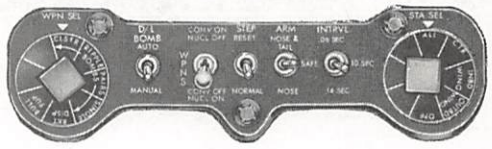
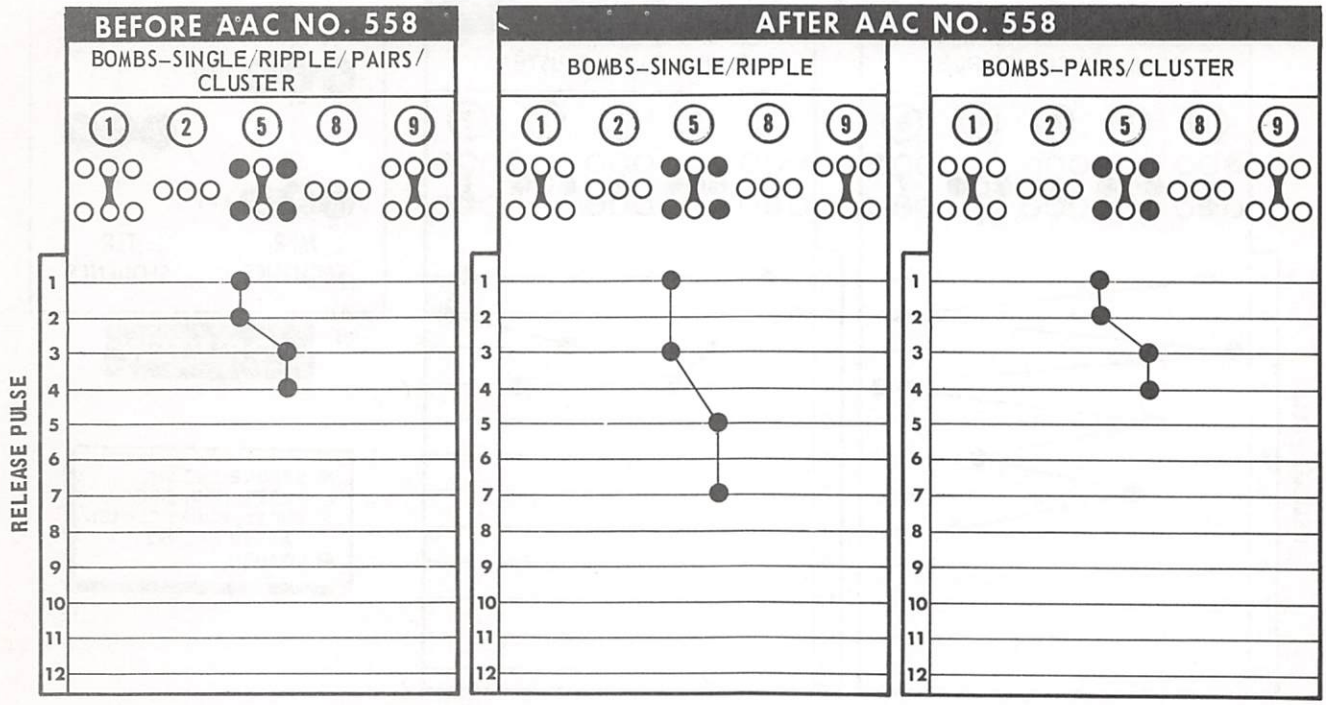
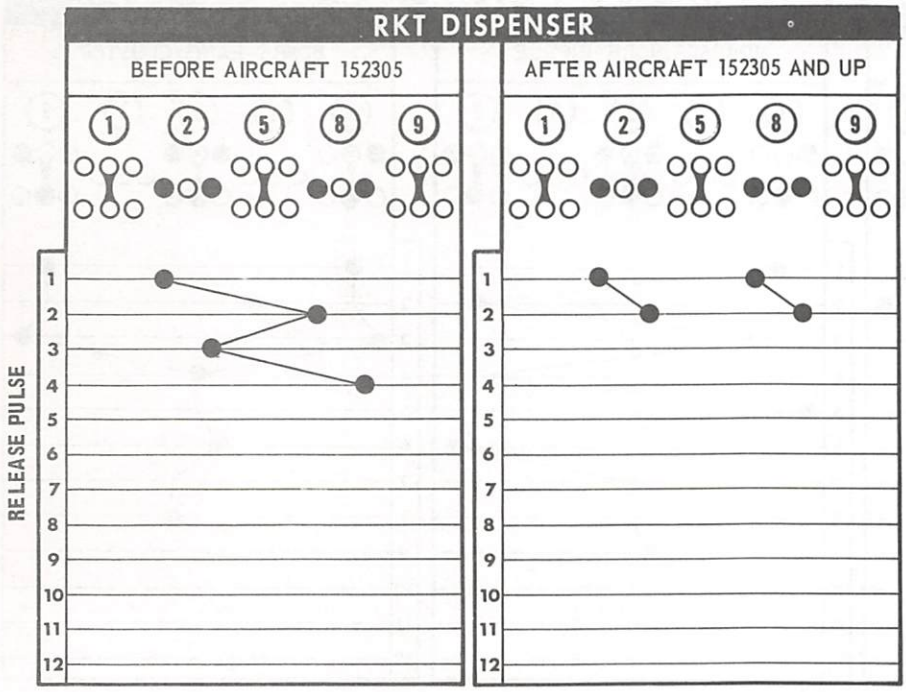


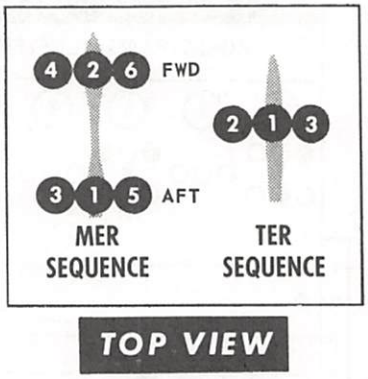
Figure 2-3 (U) (Sheet 1 of 2)

NORMAL RELEASE SEQUENCE (CONTINUED)









UNCLASSIFIED

FDB-1T-(99-2)

Figure 2-3 (U) (Sheet 2 of 2)

(U) Interval Switch

(U) The interval switch is a three-position toggle switch on the multiple weapons control panel. The switch positions are .06 SEC, .10 SEC, and .14 SEC. These positions determine the rate at which the aircraft intervalometer will pulse when the weapons selector switch is in the BOMBS RIPPLE or the BOMBS CLUSTER mode. When the weapons selector is on BOMBS RIPPLE, the selected interval pulse alternates between the left and right armament circuits. When the weapons selector is on BOMBS CLUSTER, the selected interval pulse is supplied simultaneously to both left and right armament circuits. Refer to Suspension Equipment, Normal Operation.

(U) FUZE FUNCTION CONTROL SET (AN/AWW-1)

(U) The fuze function control set (figure 2-4) provides direct current power necessary for charging and electrically arming bomb fuzes in conjunction with the master arm switch and the bomb release button. The set electrically arms conventional bombs which are to be dropped using the multiple weapons system. The amplifier-power supply is mounted in the lower center compartment of the nose wheel well, and a fuze function control panel mounted on the pilot's right console (figure 2-4). The fuze function control set electrically arms bombs carried by the airplane on the two outboard wing armament stations, the two inboard wing armament stations, and the centerline armament station.

WARNING

Oscillator plug-in units and the retaining fuzing templates of the fuze function control set AN/AWW-1 must be removed from the aircraft.

(U) Power Switch

(U) The power switch on the fuze function control panel has three positions; SAFE, STBY, and READY. In SAFE, the switch is open and all power is removed from the set. In STBY, power is applied to the filaments of all vacuum tubes and to a 30-second time delay relay in the amplifier-power supply section of the set. The time delay relay prevents the high voltage circuits from being energized until the vacuum tube filaments reach operating temperature. In READY, power is applied to the dc circuits when the option selector switch is in any dc position (positions E, F, G and H). Although the power switch is in the READY position, operating voltage will not be applied until after the 30-second time delay. The STBY position has little application in the aircraft; however, the STBY position may be used for several minutes to warm up the filaments, if desired. Moving the power switch from SAFE directly to READY is acceptable, provided at least 30 seconds is allowed for warm up prior to first bomb release.

(U) Option Selector Switch

(U) The option selector switch is an eight-position rotary switch used to select the level of dc voltage provided for fuze charging. Only position E is used for M990E dc-only, while positions E, F, G, and H are used in conjunction with the MK 344/376 dc electric bomb fuze.

Note

Options A through D give the same output as option E with the oscillator unit removed. Refer to figures 2-17 and 2-23 for AWW-1 Option Selector Settings.

(U) Press-To-Test Switch

(U) The press-to-test switch does not check AWW-1 output; therefore, this switch has no airborne function and does not test the High Voltage D-C Lamp.

(U) High Voltage D-C Check Lamp

(U) Illumination of the high voltage dc lamp indicates the power supply circuit and portions of the switching circuitry are functioning properly. Loss of HV D-C light after initial illumination usually indicates shorted circuit and blown 1/4 amp fuses. Electrically fuzed bombs will dud if dropped while the high voltage D-C light is off. The weapons switch must be in CONV ON-NUCL OFF to provide warmup power. The AWW-1 thermal relay closes to turn on the HV DC light after filaments warmup.

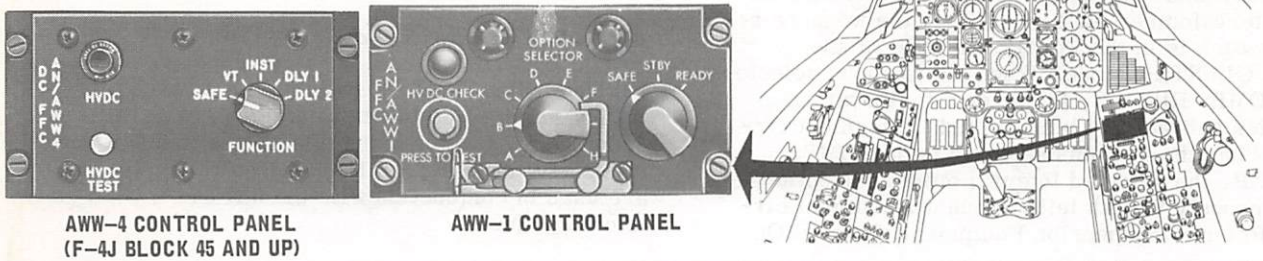
(U) FUZE FUNCTION CONTROL SET (AN/AWW-4), F-4J158346as & UP

NEW NEW NEW NEW NEW NEW

(U) The AN/AWW-4 Fuze Function Control Set provides four discrete DC voltages used for charging and arming of electric bomb and missile fuzes. Electrical power is supplied to the fuzes via the internal aircraft wiring, the bomb arming units in the bomb rack, and electrical cabling within the bombs and missiles.

(U) Various bomb rack arming assemblies can be used but all employ a common design safety feature: Electrical power cannot be transferred to the bomb fuze until the bomb has actually separated from the rack and is falling away. At this point, a pull switch makes momentary contact and transfers power to the fuze before circuit continuity is finally broken.

FUZE FUNCTION CONTROL SETS



AWW-4 CONTROL PANEL (F-4J BLOCK 45 AND UP)

AWW-1 CONTROL PANEL

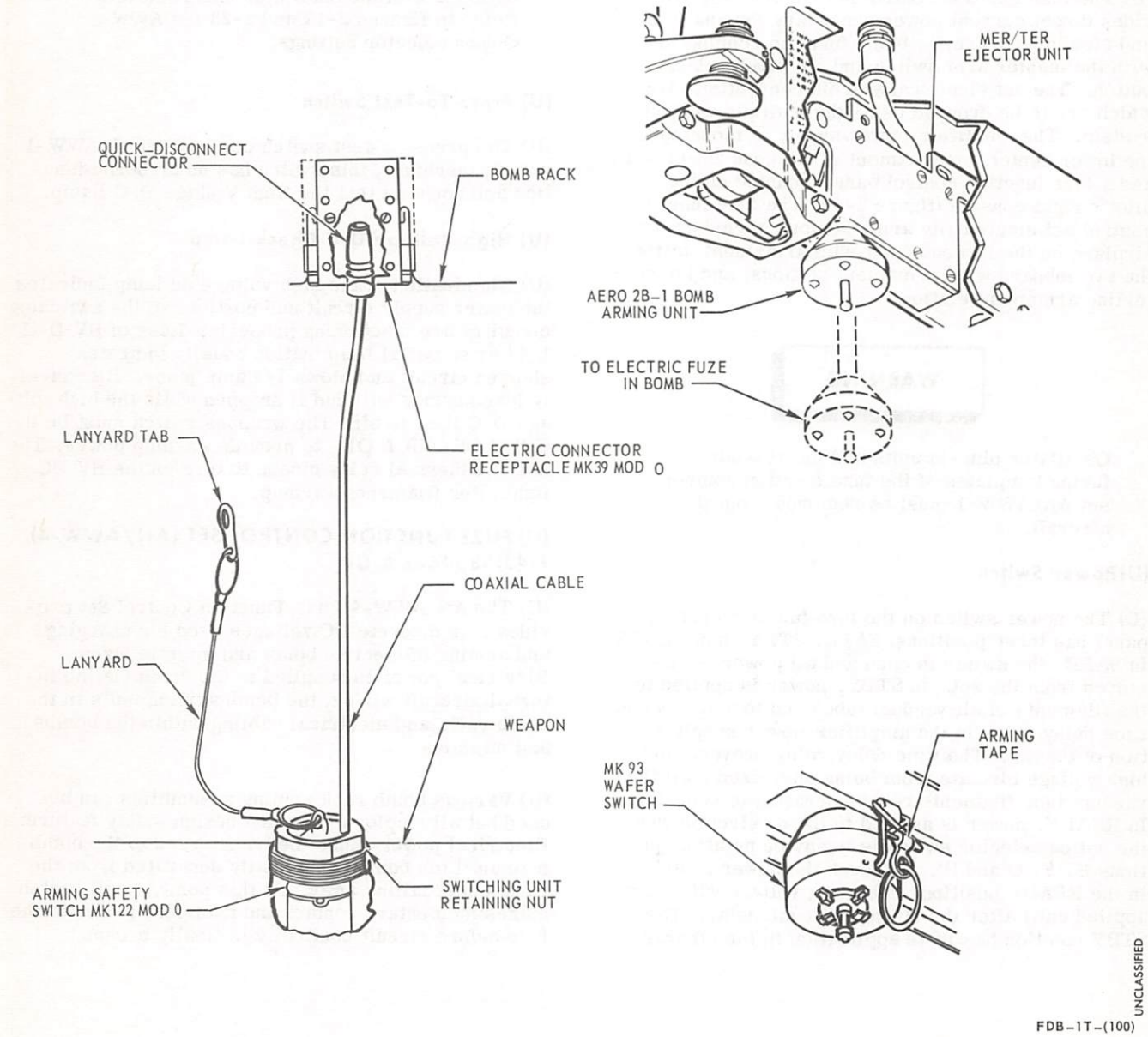


Figure 2-4 (U)

(U) AWW-4 Controls

(U) The AWW-4 cockpit control panel (figure 2-4) has a function switch, a HV DC test button, and a HV DC indicator lamp. The function switch permits selection of one of the following voltages:

Switch Position	Voltage
SAFE	Power is disconnected from system
VT	+300 volts
INST	+195 volts
DLY 1	-195 volts
DLY 2	-300 volts

Note

Because the AWW-4 has solid state circuitry, there is no STANDBY or warmup position.

(U) Under normal operation, the HV DC test button serves no purpose, either in-flight or on the deck. An emergency function is described under AWW-4 Emergency Procedures.

(U) The HV DC indicator lamp lights whenever the high voltage circuits in the AWW-4 power supply have been energized. When the system is operating properly, the HV DC lamp will light when the function switch is set to any of the four high-voltage positions. It will not light if the function switch is at SAFE. The lamp does not indicate that voltage is available at the bomb rack. The press-to-test feature of the lamp will not operate when the function switch is SAFE, or when, through malfunction, power is not available for the cockpit control unit. A standard DIM control is incorporated to control lamp intensity.

(U) When the bomb release button is depressed, a triggering voltage is supplied to the power supply. This voltage operates an internal relay which transfers DC voltage to the output of the power supply and to the bomb racks.

(U) AWW-4 Emergency Procedures

(U) If the HV DC lamp fails to light when the FUNCTION switch is set to one of the four operating positions, perform the following steps:

1. Check that DIM control on lamp housing is set to full brightness (counter-clockwise).
2. Depress lamp housing. If lamp does not light, it can indicate two things: (1) voltage is not being applied to the system and any weapons released will dud, or (2) lamp is defective in which case, bombs can be dropped live in the normal mode. Mission requirements should dictate the action, to abort the mission or to chance dropping duds.
3. If lamp lights when housing is depressed, depress HV DC TEST button. If the HV DC indicator lamp lights, an armed drop can be made by pressing the HV DC TEST button and the bomb release switch simultaneously during bomb release. If lamp does not light when HV DC TEST button is depressed, the system is inoperative.

(U) AERO 2B-1 BOMB ARMING UNIT

(U) The dc arming signal outputs are routed from the AWW-1 fuze function control set, through the Aero 2B-1 bomb arming units, and to the electric bomb fuzes. Six arming units are contained in the MER and three arming units are contained in the TER. The arming unit consists of a spring-loaded pulley, two microswitches, and a molded rubber cable and plug assembly (figure 2-4). The plug assembly is plugged into the bomb when the bomb is loaded to the MER/TER. When the bomb is released, the spring-loaded pulley unit unwinds to full length before the plug assembly is pulled from the bomb and snapped back into the bomb arming unit. When the cable unwinds to a length of 3 inches, a microswitch operates to apply the arming signal to the electric fuze.

(U) MK 39 CONNECTOR

(U) After AAC 437, the MK 39 Connector (figure 2-4) replaces the Aero 2B-1 Bomb Arming Unit to provide increased reliability. AAC 437 is a modification to the MER/TER. Refer to AAC 437 for MER/TER reidentification data and federal stock numbers. The MK 39 connector provides the interface between the aircraft fuze function control set and the expendable cable (MK 122 Mod 0 Arming Safety Switch).

(U) MK 122 Mod 0 Arming Safety Switch

(U) The MK 122 Mod 0 arming safety switch (figure 2-4) is an expendable item that replaces the MK 93 wafer switch and cable portion of the Aero 2B-1 Bomb Arming Unit. The MK 122 forms the connection between aircraft and the bomb and serves as a RADHAZ (Radiation Hazard) protection device. The MK 122 provides improved reliability and increased RADHAZ protection over the Aero 2B-1 unit. Two types are presently in fleet inventory:

a. The original MK 122 Mod 0 includes a long, tight fitting, rubber protective cap installed over the aircraft end of the cable.

b. The Type II design, currently in production, has a raised metal collar at the bomb end of the cable for additional strength. The rubber protective cap has been shortened and is not installed on the cable. It is used only in a download situation where the plastic insert in the cable has been punctured.

(U) ELECTRIC BOMB FUZE SYSTEM OPERATION

(U) Electric bomb fuzing system operation is as follows:

1. The fuze options and initiating voltages are listed on each fuze data sheet in the Fuzing and Fuze Limitation section. These data sheets indicate the correct FUNCTION switch setting for each operating mode.

2. Operating and checkout procedures for the AWW-1 and AWW-4 are provided under Bomb Release from MER/TER which follows. En-route to the target, the pilot energizes the system and sets the FUNCTION switch to the desired fuzing option. AWW-1 operation requires several minutes in STANDBY to warm up the tube filaments. The AWW-4 requires no warm-up time.
3. The pilot notes that the HV DC indicator lamp on the Fuze Function Control panel is illuminated, indicating system readiness. The light should be re-checked prior to each bombing run.
4. At bomb release, the release pulse triggers the output relay of the AWW power supply and transfers power to all of the bomb stations.
5. As the ejector rack fires, and the forward hook opens, the hook-sensing microswitch in the electrical bomb arming unit closes and transfers power to the MK 122 Arming Safety Switch (preferred).
6. After the first 6-inches of bomb travel, a lanyard extracts a pin from the bomb end of the MK 122 cable. This action completes the circuit to the bomb fuze and charges the arming and firing capacitors in the fuze. The MK 122 arming safety switch provides two functions: it acts as a RADHAZ shield for the fuze during loading and carriage and ensures that the bomb is falling clear of the rack before allowing charging power to be transferred to the fuze.
7. After 12-inches of bomb travel, the MK 122 cable pulls clear of the electrical bomb arming unit and fuze initiation is complete.
8. During the initial bomb travel, the MK 3 arming wire, which is positively rigged to the bomb rack, is extracted from the mechanical pop-out pin on the fuze safety device. This allows electrical arming to continue, and in the case of MK 376 delivery, initiates the retard sensing circuits.
9. Arming and functioning actions of the fuze are controlled by the electrical energy imparted to the fuze at bomb release.

(U) NORMAL OPERATION

(U) The following procedures are presented in the Tactical Manual Pocket Guide NAVAIR 01-245FDB-1T(B).

(U) MER/TER RELEASE PROCEDURES

1. Reticle dep knob - SET
2. Bomb control sw - DIRECT (some acft)
3. Wpn sel knob - BOMBS
4. Step reset sw - RESET (auto home)
5. (Mech fuze) nose/tail arm sw - SET
6. Interval sw - SET
7. Sta sel knob - LOADED STA
8. Wpns sw - CONV ON/NUCL OFF
9. (Elec fuze) AWW-1 Controls:
   a. Pwr sel knob - READY (30 sec DC)
   b. AWW-1 option sel knob - SET
   c. HV DC red light - ON (after 30 sec)
10. (Elec fuze) AWW-4 Controls:
    a. Dim control - FULL CCW
    b. AWW-4 function switch - SET
    c. HV DC light - ON
11. Bomb button - DEPRESS

(U) EMERGENCY BOMB RELEASE

1. Wpn sel knob - BOMBS/RIPPLE
2. Repeat (4) thru (11), hold bomb button depressed 4 sec.
3. AWW-4 Analysis/Emergency Procedure:
   a. AWW-4 Function switch - NOT IN SAFE
   b. Press-to-test lamp.
      (1) If lamp lights, perform step c.
      (2) If no light, AWW-4 is inoperative and fuze will dud, or only the lamp is burned out and the fuze will arm.
   c. Press HV DC TEST button
      (1) If lamp lights, depress and hold HV DC TEST button while depressing the bomb release button; fuze will arm.
      (2) If no light, AWW-4 is inoperative; fuze will dud.

(U) Inflight Rehoming (MER/TER)

1. Wpn sel knob - RKT DISP
2. Wpn sel knob - AS DESIRED
3. Step reset sw - RESET (if necessary)

Note

Rehoming occurs on all MERS/TERS regardless of sta sel sw setting and wpns sw position.

(U) PMBR RELEASE PROCEDURES

1. Reticle dep knob - SET
2. Bomb control sw - DIRECT (some acft)
3. Wpn sel knob - BOMBS
4. Interval sw - SET
5. Sta sel knob - LOADED STA
6. Wpns sw - CONV ON/NUCL OFF
7. Bomb button - DEPRESS

(U) ROCKET FIRING PROCEDURES

Note

For LAU-33A/A Rocket launcher, use AIM-9 Launch Procedures, section I.

1. Reticle dep knob - SET
2. Bomb control sw - DIRECT (some acft)
3. Wpn sel knob - RKT DISP
4. Step reset sw - RESET (auto home)
5. Sta sel knob - LOADED STA
6. Wpns sw - CONV ON/NUCL OFF
7. Bomb button - DEPRESS

(U) ROCKET POD RELEASE FROM MER/TER

1. Wpn sel knob - BOMBS/RIPPLE
2. Repeat (4) thru (7), hold bomb button depressed 4 sec.

(U) Inflight Rehoming (MER/TER)

1. Wpn sel knob - RKT DISP
2. Wpn sel knob - AS DESIRED
3. Step reset sw - RESET (if necessary)

Note

Rehoming occurs on all MER/TERS regardless of sta sel sw setting and wpn sw position.

(U) CBU DISPENSING PROCEDURES

1. Reticle dep knob - SET
2. Bomb control sw - DIRECT (some acft)
3. Wpn sel knob - RKT DISP
4. Step reset sw - RESET (Auto home)
5. Interval sw - SET
6. Sta sel knob - LOADED STA
7. Wpns sw - CONV ON/NUCL OFF
8. Bomb button - DEPRESS

(U) DISPENSER RELEASE FROM MER/TER

1. Wpn sel knob - BOMBS/RIPPLE
2. Repeat (4) thru (8), hold bomb button depressed 4 sec

(U) Inflight Rehoming (MER/TER)

1. Wpn sel knob - RKT DISP
2. Wpn sel knob - AS DESIRED
3. Step reset sw - RESET (if necessary)

Note

For normal operation of gun pod, refer to Gunnery Equipment. For normal operation of CONLABS delivery, refer to CONLABS Release System.

(U) EMERGENCY OPERATION

(U) There is no provision for emergency operation of the multiple weapons release system. Emergency bomb release is accomplished by the normal release system and is an expendient method of releasing the weapons while retaining all suspension equipment. To clean the aircraft of all suspension equipment, refer to Jettison System, this section.

(U) LIMITATIONS

(U) Refer to External Stores Limitations, appendix A.

GUNNERY EQUIPMENT

(U) DESCRIPTION

(U) The gunnery system on F-4B 152278w and up, F-4N, and all others after AFC 241, consists of a 20mm MK 4 Mod 0 gun pod and necessary cockpit controls. The gun pod is suspended from a MER adapter assembly on the aircraft centerline station. The pod contains a MK 11 Mod 5 gun, ammunition magazine, ammunition feed system, pneumatic system and electrical system. This system is a self-contained unit which, except for aircraft electrical power, provides all the energy for its operation. The gun has two fixed barrels, mounted one above the other, which fire simultaneously, except for the first and last round. A fast firing rate of 4000 ± 200 rounds per minute or a slow firing rate of 700 ± 100 rounds per minute can be selected prior to flight by a switch contained within the pod.

(U) The gun pod fires electrically primed 20mm ammunition, MK 100 series, type HPT (high pressure test), LPT (low pressure test), HEI (high explosive incendiary), TP (target practice), API (armor piercing incendiary) and APT (armor piercing tracer). The gun pod has an ammunition capacity of 750 rounds. The accuracy of the gun is a radial dispersion of 6 mils for 80% of the projectiles.

(U) While firing, the gun is operated by power derived from the gun recoil, gun gases, and the pneumatic system. The ammunition feed system (which serves to transport belt-linked ammunition from the magazine to an ammunition loader) consists of two ammunition feed chutes, two sprocket assemblies, and a pneumatic motor. The ammunition loader also contains a loader sprocket assembly which accepts two linked belts from the ammo chutes and rotates them into position for insertion into the revolver cylinder chambers. In addition, the loader retains the roundless links until the spent cartridges are ejected back into the links and discharged overboard. The loader sprocket can be decoupled by a pneumatically operated clutch for purposes of clearing the gun. The pneumatic system is also used for gun charging and gun clearing. During the gun charging sequence, high pressure air rotates the revolver cylinder and rams the rounds into the cylinder chambers. During gun clearing, high pressure air rotates the revolver cylinder and ejects the unfired rounds from the cylinder chambers. An automatic charging and dud sensing circuit in the electrical system automatically recharges the gun when a round does not fire. If an empty cartridge case fails to eject, cylinder rotation will stop, thereby preventing a double feed.

(U) GUN POD CONTROLS (F-4B/N & F-4J thru 158354as Before AFC 506)

(U) Gun pod controls (figure 2-1) are in the front cockpit and consist of the weapons (WPNS) switch on the multiple weapons control panel, the guns switch on the auxiliary armament control panel, and the missile trigger switch on the control stick. On F-4J 155890am and up, also F-4B and other F-4J after AFC 451 and F-4N, the gun switch is on the multiple weapons control panel.

(U) Weapons Switch

(U) The weapons (WPNS) switch has two positions; CONV ON - NUCL OFF and CONV OFF - NUCL ON. The CONV ON - NUCL OFF position supplies power to the gun pod firing circuits.

(U) Guns Switch

(U) The guns switch has three positions; OFF, READY and CLEAR. The READY position supplies power to the charging circuits of the gun pod, controls power to the gun pod firing circuits, and switches the missile trigger switch into the gun firing circuits. The CLEAR position, spring-loaded back to the OFF (center) position, supplies power to the gun clearing circuit.

Note

On airplanes 153030aa and up and F-4N, the GUNS switch locks in the OFF and READY positions, and must be pulled up before repositioning.

(U) Missile Trigger Switch

(U) The missile trigger switch, when depressed, fires the guns, provided the weapons switch is in the CONV ON-NUCL OFF position, the nose gear is up, and the guns switch is in the READY position.

(U) GUN POD CONTROLS (F-4J 158355at & Up, All Others After AFC 506)

(U) Weapon Select Switch and Weapon Selected Light

(U) The weapon select switch is on the control stick (figure 2-1). The switch is spring loaded to the off position (center). When momentarily positioned to GN (gun), power is applied to energize the gun select holding relay and to the gun charging relay to charge the gun. Gun selection is indicated by illumination of the GN weapon selected light. The gun is de-selected by selecting another weapon (SW/SP/SS) or by momentarily positioning the warning lights switch to WPN LTS RESET. The gun select relay is now deenergized to interrupt trigger fire power to the gun and remove power from the GN weapon selected light and the weapon READY light.

Note

The gun charging relay is deenergized only when the GUN CLR position is selected. The gun remains charged once selected. The gun will charge when selected regardless of gun/missile arm switch position, except GUN CLR (gun clear).

(U) Gun/Missile Arm Switch and Weapon READY Light

(U) The gun/missile arm switch (figure 2-1) has three positions: ARM, SAFE, and GUN CLR (gun clear). The ARM position applies power to the arm safe relays which allows power to be applied to the trigger switch and to illuminate the weapon READY light. The weapon READY light illuminates if a weapon is selected (GN light on) and the gun pod is ready to fire. Power is removed from the READY light after the warning lights switch is positioned to WPN LTS RESET, even though the arm safe relay remains energized. (Weapon selection is necessary to obtain a READY light.) The SAFE position deenergizes the arm safe relay.

Note

The switch must be pulled out of detent for each position selected. Observe extreme care when positioning the switch from ARM to SAFE to avoid entering the GUN CLR (gun clear) position.

(U) When GUN CLR is selected, the gun charging relay is deenergized and a gun charge lockout relay is energized. All 20mm rounds are ejected from the gun pod chambers. After GUN CLR is selected, the lockout relay remains energized for the remainder of the flight until power is removed from the aircraft. It is not necessary to have previously charged the gun, nor to have the gun selected, to energized the gun charge lockout relay. The gun charge lockout relay is energized any time GUN CLR is selected if the nose gear is up.

(U) Warning Lights Switch

(U) The WPN LTS RESET (weapon lights reset) position on the warning lights switch deenergizes the weapon select relays and removes power from the weapon selected lights. The switch must be lifted up, out of detent before the WPN LTS RESET momentarily position can be selected.

(U) Trigger Switch

(U) Power is available at the trigger when the nose gear is up and the gun/missile arm switch is in ARM. Power from the trigger to fire the gun pod is available when the gun is selected and armed (GN and READY lights on).

(U) NORMAL OPERATION

(U) Prior to firing, the gun is charged by cycling the guns switch to the READY position. During the cycling of the guns switch, the gun pod charging circuit energizes a charge solenoid valve, allowing high pressure air from the pneumatic system to cycle the gun through recoil and counter recoil, to rotate the revolver cylinder 45°, placing two chambered rounds in the firing position. At the same time, a pneumatic motor solenoid valve is energized to operate the feed system pneumatic motor which pulls the two ammo belts from the magazine. As the gun revolver cylinder rotates, the loader sprocket takes a round from each belt and positions them for ramming into chambers 180° apart in the revolver cylinder. During gun counter recoil, pneumatic pressure rams the two rounds into the chambers. The gun is now charged and ready for firing.

(U) After firing, the spent cartridges are rotated another 45° where they are mechanically extracted and then ejected back into their original ammunition belt links by gun-gas pressure from the next succeeding rounds. The links, with the spent cartridges, separate from the belt and are discharged overboard as a unit. A last round switch shuts down the feed system; however, the loader continues to pull through the rounds remaining in the ammunition chute for a complete fireout.

(U) If any rounds are left in the gun chambers, such as when the magazine is not fired out, the rounds can be cleared by actuation of the guns switch to the CLEAR position. The CLEAR position cycles the gun in the same manner as a charging cycle except that no rounds are rammed into the revolver cylinder chambers. This deactivates the magazine motor and declutches the loader sprocket, thus preventing any new rounds from being rammed into the gun chambers. The rounds remaining in the gun chambers are rotated and ejected until the gun is cleared. Holding the guns switch to the CLEAR position for 0.5 second clears the gun of all rounds in the gun chambers.

CAUTION

Do not fly below or behind an aircraft that is in a firing run, to prevent damage from ejected cases and links.

Note

- Long burst firing and fast fireouts overheat the gun and should be avoided to assure parts life and reliability. A total of 15 minutes should be allowed during fireout of a fully loaded pod. Burst lengths of 1-1/2 to 2 seconds with 3 minute cooling between passes are recommended; however, the gun is capable of firing a 6-second burst. Refer to figure 2-85 for firing burst length schedules.
- The incidence rate of gun malfunctions during firing increases rapidly above 4G.

CAUTION

Do not recharge the gun once it has been cleared, because the empty links left in the feed sprocket during clearing causes a link jam.

Note

The gun pod weighs 1390 pounds fully loaded with a CG located 21.6 inches aft of the forward mounting lug. With the magazine empty the pod weight 787 pounds with CG located 5.6 inches aft of the forward mounting lug.

NEW (U) GUN FIRING PROCEDURES (F-4B/N & F-4J thru 158354as Before AFC 506)

(U) If the gun control switches and the missile control switches are positioned for firing, only the gun fires when the trigger switch is actuated. The guns switch must be out of the READY position for the missiles to fire. The following procedures are contained in the Tactical Manual Pocket Guide NAVAIR 01-245FDB-1T(B).

1. Reticle dep knob - SET (check gun bore line parallel to FRL or 2° below FRL) NEW
2. Guns sw - READY
3. Wpns sw - CONV ON/NUCL OFF
4. Missile trigger sw - DEPRESS

Note

Between firing runs, leave the guns switch in the READY position. Cycling the switch to OFF and back to READY results in wasting ammunition and prematurely depleting the pneumatic reservoir. For interim safing of the system, place the weapons switch to CONV OFF - NUCL ON.

(U) To Safe Guns:

5. Wpns sw - CONV OFF - NUCL ON

(U) Before Landing

1. Wpns sw - CONV OFF - NUCL ON
2. Guns sw - CLEAR (hold 0.5 sec.)
   Momentarily actuate the guns switch to CLEAR to remove all rounds from loaded chambers.
3. Guns sw - OFF

CAUTION

Do not recharge the gun once it has been cleared. The empty links left in the feed sprocket during clearing will cause a link jam.

(U) GUN FIRING PROCEDURES (F-4J 158355at & Up, All Others After AFC 506)

(U) The following procedures are contained in the Tactical Manual Pocket Guide NAVAIR 01-245FDB-1T(B).

1. Reticle dep knob - SET (check gun bore line parallel to FRL or 2° below FRL) NEW
2. Weapon select switch - GN
   a. Weapon selected light - GN

Selecting GN charges the gun.

3. Gun/missile arm switch - ARM
   a. Weapon READY light - ON
4. Trigger switch - DEPRESS

Note

For interim safing of the gun system between firing runs, position gun/missile arm switch SAFE or momentarily position the warning lights switch to WPN LTS RESET.

(U) To Safe Gun:

5. Gun/missile arm switch - SAFE
   a. Weapon READY light - OFF

(U) Before Landing

1. Gun/missile arm switch - GUN CLR (hold 0.5 sec)
2. Gun/missile arm switch - SAFE
   a. Weapon READY light - OFF
3. Warning lights switch - WPN LTS RESET
   a. Weapon selected lights - OFF

(U) EMERGENCY OPERATION

(U) There are no special provisions for emergency operation of the gunnery system. However, the gun pod can be jettisoned in the same manner as any other jettisonable conventional weapon suspended from the centerline station.

(U) LIMITATIONS

(U) Refer to External Stores Limitations, appendix A.

CONLABS RELEASE SYSTEM

(U) DESCRIPTION

(U) GENERAL

NEW

(U) The Conventional Low Altitude Bombing System (CONLABS) delivery mode is available in F-4B aircraft after AFC 336, in F-4J aircraft thru 155528ag after AFC 388, and in F-4J aircraft 155529ag and up, and F-4N. Some aircraft may have been modified as described in VX-5 AEN (LTR Ser 074 dtd 22 Sept. 1966). These aircraft require the use of the center station switch and the addition of a CONLABS selector switch to the bomb control panel. The function of the bomb control switch is changed in aircraft modified by AFC 336/388, and the addition of a CONLABS selector is not required.

(U) The following is a description of the controls and indicators used to accomplish the CONLABS delivery mode. Refer to part 3, CONLABS Delivery, for a description of delivery technique. Refer to part 4, CONLABS Sample Problem and CONLABS Delivery Data for mission planning data.

(U) ATTITUDE REFERENCE BOMBING COMPUTER SET

NEW

(U) The attitude reference bombing computer set (ARBCS) is utilized to perform the CONLABS delivery (loft). In F-4B/N aircraft, the equipment consists of the AN/AJB-3A set; whereas, the F-4J aircraft is equipped with the AN/AJB-7 set. The controls and indicators applicable to both sets are shown in figure 2-5. These components, as utilized to perform the CONLABS delivery, are discussed in the following text. Refer to F-4B/J/N NATOPS Manuals for information concerning navigational capabilities and to NAVAIR 01-245FDB-1T(A) for information concerning the ARBCS are used in the nuclear Release System.

NEW

(U) ATTITUDE DIRECTOR INDICATOR

(U) The attitude director indicator (ADI) functions in the following manner after the bomb release button is depressed in a CONLABS delivery mode. The bomb button release signal starts the LABS timer and disconnects control voltages from the ADI vertical and horizontal needles. Both needles are deflected to center and serve no purpose until completion of timer count-down. Upon completion of timer count-down, a pullup signal is generated which energizes the needles and activates the G programmer. The G programmer starts a linear, 4.0 G in 2 seconds program. The G level experienced by the aircraft and sensed by the accelerometer is compared to the programmed G level. A resultant G error signal is applied to the horizontal needle. In order to establish and hold a 4 G pullup attitude in 2 seconds, the pilot applies full military power and keeps the horizontal needle centered throughout the loft maneuver. During the pullup maneuver, the vertical needle senses deviations (error signals) in roll and/or yaw. These error signals cause the vertical needle to move off center. The pilot centers the vertical needle by rolling the aircraft in the direction of needle deflection. The ADI indicating sphere provides continuous roll, pitch and azimuth displays; however, the vertical and horizontal needles are the prime attitude indicators throughout the pullup maneuver.

Note

- The CONLABS delivery is aborted after initiation, by releasing the bomb button, or by excessive yaw during the programmed pullup maneuver. Yaw limits in F-4B/N aircraft (AJB-3A system) are approximately 12°. These limits are extended to approximately 30° in F-4J aircraft (AJB-7 system).

NEW

- In F-4J aircraft, with the AN/APG-59 operating in the TERR (terrain clearance) mode, the ADI horizontal needle is deactivated and remains out of view.

(U) BOMB CONTROL PANEL

(U) The switches on the bomb control panel are used to perform the CONLABS delivery and nuclear weapons release. In F-4J aircraft 154786ag and up and in

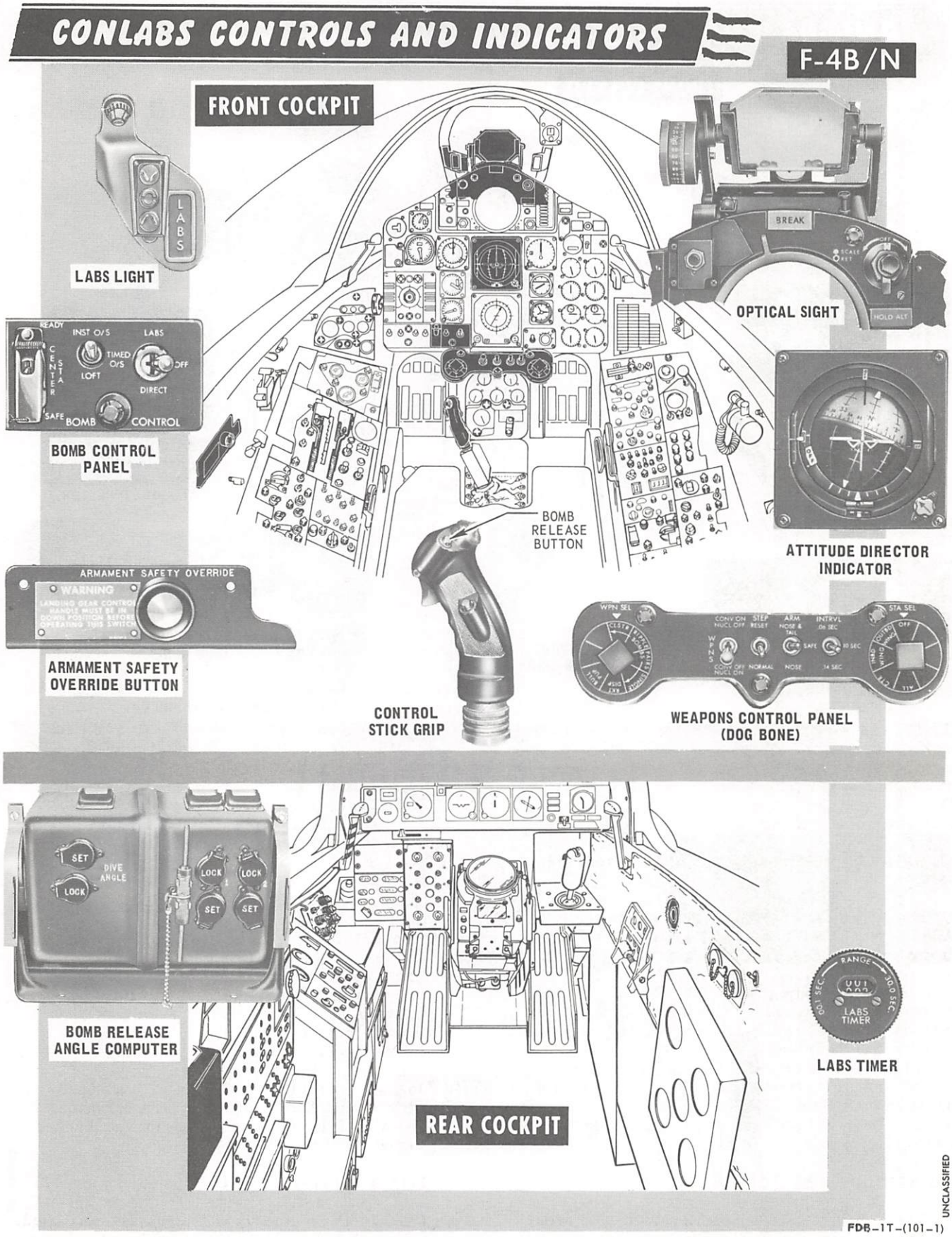


Figure 2-5 (U) (Sheet 1 of 2)

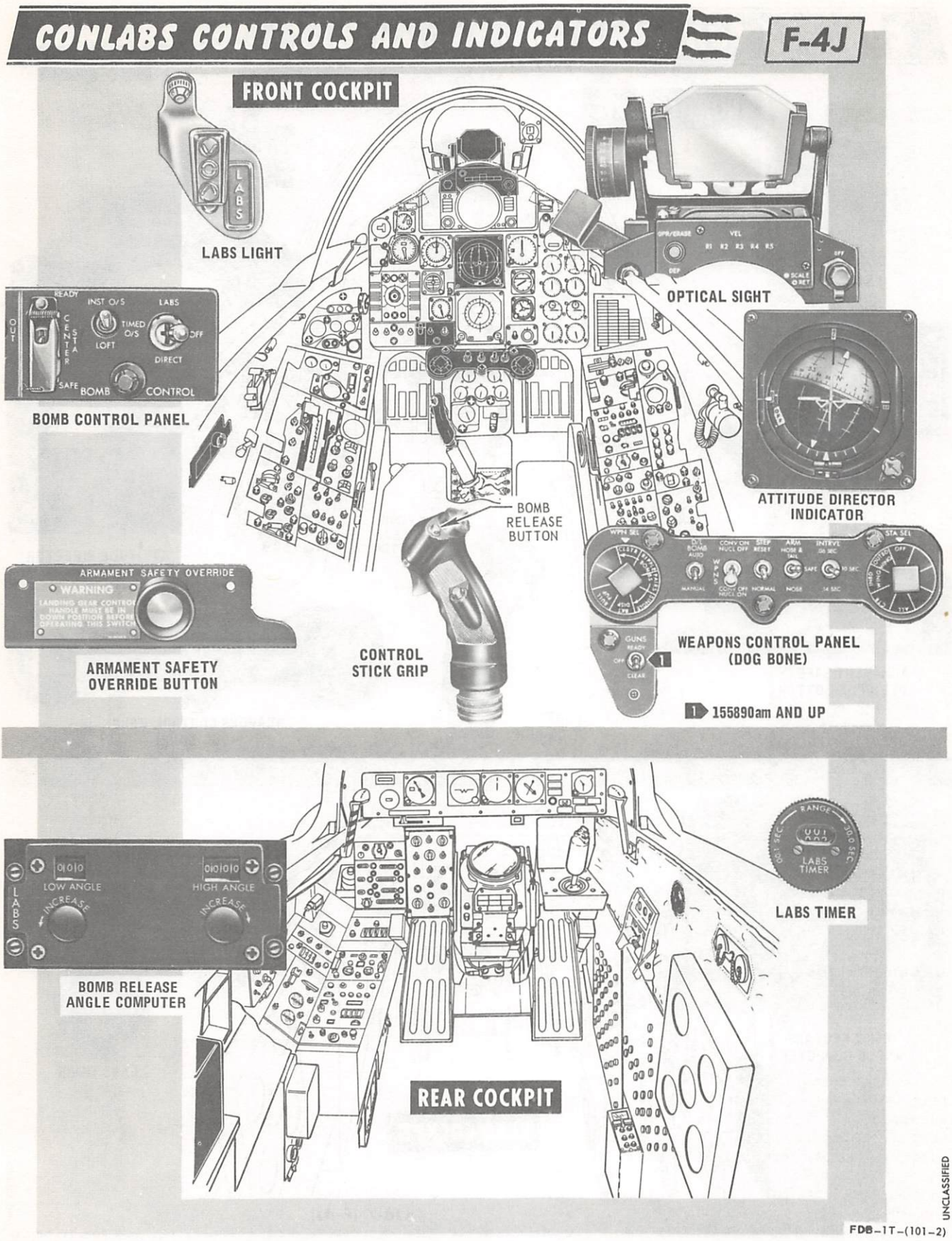


Figure 2-5 (U) (Sheet 2 of 2)

NEW F-4J aircraft 153768ab thru 154785af after AFC 388, and in F-4B aircraft after AFC 336 and F-4N, the bomb control switch on the bomb control panel is used to perform multiple weapons release

(U) Bomb Control Switch

(U) The bomb control switch has three positions; LABS, OFF, and DIRECT. The LABS position selects the AN/AJB-3 or -7 low altitude bombing system. The actual LABS bombing mode selected is determined by one or two other switches (the weapon switch and/or the LABS Mode switch) depending upon the aircraft modification stated above. In the AFC modified aircraft, the CONLABS mode is selected when the weapons switch is in CONV ON-NUCL OFF; the nuclear weapons release system is selected when the weapons switch is in CONV OFF-NUCL ON. For all aircraft, if the bomb control switch is in OFF, bomb release cannot occur using the nuclear release system. In the AFC modified aircraft, both the nuclear and multiple weapons release systems are disabled when the bomb control switch is in OFF. The DIRECT or LABS position must be used to obtain a bomb release. When DIRECT is selected, bomb release or rocket launch occurs immediately as the bomb button is depressed.

(U) LABS Mode Switch

(U) The LABS mode switch is functional only when the bomb control switch is in LABS. The LABS mode switch has three positions; INST O/S (instant over-the-shoulder), TIMED O/S, and LOFT. The LOFT position selects the LOW ANGLE or RA-1 portion of the bomb release angle computer and the LABS timer. The TIMED O/S position selects the HIGH ANGLE or RA-2 portion of the bomb release angle computer and the LABS timer. The INST O/S position selects only the HIGH ANGLE or RA-2 portion of the bomb release angle computer. In the AFC modified aircraft, the number two correlator light in the radar scope camera illuminates to mark the scope film when the bomb button is depressed and a LABS mode is selected. The number two correlator light goes out when a bomb release signal is generated by the release angle computer. Refer to Attitude Reference Bombing Computer Set, this part.

(U) Center Station Switch

(U) The center station switch is cover-guarded in the SAFE position and is in series with the bomb release button. The center station switch is functional only when the weapons switch is in CONV OFF-NUCL ON. When the switch is in READY, the ejector cartridges in the Aero 27A bomb rack can be fired (to release a store, suspension equipment, gun pod, or fuel tank suspended from the Aero 27A bomb rack) if the bomb control switch is in either DIRECT or LABS. The switch may be safety wired in the SAFE position. In aircraft that have the CONLABS switch (non-AFC) the center station switch must be in READY while the weapons switch is in CONV ON - NUCL OFF. Refer to CONLABS Release System, Normal Operation, this part.

(U) CONLABS Switch

(U) The CONLABS switch (not illustrated) is added on all aircraft which have been modified for CONLABS capability prior to AFC 336/388. This switch has two positions; CONLABS ON and CONLABS OFF. The switch must be in CONLABS OFF for normal releases with the multiple weapons release system. For CONLABS delivery, the CONLABS switch must be in CONLABS ON, the weapons switch must be in CONV ON - NUCL OFF, the center station switch must be in READY, the bomb control switch in LABS and the LABS mode switch in LOFT.

(U) BOMB RELEASE BUTTON

(U) The bomb release button must be depressed and held during the CONLABS delivery maneuver. If the bomb control switch is in the DIRECT position and the bomb button is depressed, bomb release occurs instantaneously. With LABS selected the bomb button, when depressed, starts the LABS timer, and when released, removes voltage from the LABS timer, allowing the timer to reset.

(U) BOMB RELEASE ANGLE COMPUTER, AN/AJB-3A (F-4B/N)

(U) The bomb release angle computer (figure 2-5) is not easily accessible in flight. The preplanned release angle, obtained from CONLABS delivery data part 4, should be set into the computer before flight. The low angle (RA-1) loft release dial can be set from minus 1.45° to plus 80°. When LOFT is selected on the LABS mode switch, weapons are released when the aircraft is at the pitch angle set on the RA-1 dial. The high angle (RA-2) O/S release dial can be set from plus 80° to plus 176°. RA-2 high angle is used only when over-the-shoulder modes are selected and does not apply to the CONLABS delivery mode. The AN/AJB-3A contained in each aircraft must be individually calibrated. Two synchro calibration corrections must be made to the release angle obtained from the delivery data in part 4. These corrections (deviations) are: displacement gyro correction factor and pitch angle selector correction factor. The correction factors are listed on the computer case and must be algebraically added to the computed LABS release angle for each delivery mode.

WARNING

The low angle RA-1 release setting should not be set lower than plus 10.0°. Aircraft pitch angle variations during the timed run-in (bomb button depressed) may cause a bomb release.

(U) BOMB RELEASE ANGLE COMPUTER, AN/AJB-7 (F-4J)

(U) The AJB-7 bomb release angle computer in F-4J aircraft (figure 2-5) functions in the same manner as NEW

the AJB-3A computer in F-4B/N aircraft. However, the following differences exist in preset release angle adjustments. The computer contains a LOW ANGLE and a HIGH ANGLE adjust knob. A digital indicator window above each knob provides a visual readout of the release angle selected. The low angle knob is adjustable from 0° to 80° for the loft mode. The high angle knob is adjustable from 80° to 170°. The high angle adjustment is used only when over-the-shoulder modes are selected and does not apply to the CONLABS delivery mode.

WARNING

- In F-4J aircraft (AN/AJB-7 system) when the LABS release angle gyro is set greater than 169.0°, bomb release may occur at the pullup point when the bomb button is depressed (INST O/S) or at the completion of the LABS timer (TIMED O/S).
- The low angle release setting should not be set lower than plus 10.0°. Aircraft pitch angle variations during the timed run-in (bomb button depressed) may cause a bomb release.

Note

The AN/AJB-7 contained in each aircraft requires that a gyro error pitch correction (deviation) be algebraically added to the planned release angle. Refer to the Pitch Synchro Output Correction Chart on the Displacement Gyroscope Assembly (DGA) case, left forward side, rear cockpit.

(U) LABS LIGHT

(U) The LABS light, on a bracket suspended from the windshield, illuminates upon completion of the LABS timer count-down (pullup). The light extinguishes when the aircraft is at the preselected release angle. During a CONLABS multiple delivery, the light goes off when the release signal is generated thus, only the initial bomb release is indicated. The LABS light does not illuminate during a direct mode delivery.

(U) LABS TIMER

(U) The LABS timer provides accurate count-down time measurements during all timed LABS modes. The timer contains a speed-regulated, 28 volt dc motor with associated switches, a mechanical clutch and solenoids. The timer dial can be set in 0.1-second increments, from 0 to 30 seconds. In a CONLABS delivery mode the preset count-down commences and the vertical/horizontal needles center when the bomb button is depressed and held. Preflight calculations determine the required time interval from IP to pullup. One second before completion of timer count-down, the timer initiates a pullup warning tone of 1/4 to 1/2-second duration. When timer count-down is completed (timed out), the timer initiates the steady pullup tone, illuminates the pullup light and starts the pullup programmer. The timer resets (recycles) when the bomb button is released. During the pullup maneuver, the LABS light is illuminated, the vertical needle indicates deviations in roll/yaw, and the horizontal needle programs a 4 G pullup in 2 seconds. When the first bomb is released, the LABS light goes out, the pullup tone ceases, the vertical needle deflects out of view, and the horizontal needle continues to indicate the 4 G pullup G error. When the bomb button is released, the horizontal needle deflects out of view, the pullup programmer stops, the vertical needle returns to the selected function, and the LABS timer recycles.

Note

For multiple bomb CONLABS deliveries, assure release button is held until all weapons have left the aircraft. Releasing button at termination of tone and light results in an incomplete drop.

(U) MULTIPLE WEAPONS CONTROL PANEL

(U) Refer to Multiple Weapons Release System.

(U) ARMAMENT SAFETY OVERRIDE BUTTON

(U) Refer to Multiple Weapons Release System.

(U) NORMAL OPERATION

(U) The following procedures are repeated in the Pocket Guide.

(U) CONLABS DELIVERY PROCEDURES

1. Low angle or RA-1 sector setting - SET
2. LABS timer - SET
3. CONLABS sw - CONLABS ON (Non-AFC modified aircraft only)
4. Center sta sw - READY (Non-AFC modified aircraft only)
   a. Center sta sw - SAFE (AFC modified aircraft)
5. LABS mode sw - LOFT
6. Bomb control sw - LABS
7. Wpn sel knob - BOMBS
8. Step reset sw - RESET (Auto home)
9. Interval sw - SET
10. Sta sel knob - LOADED STATIONS
11. (Mech fuze) nose/tail arm sw - SET
12. Wpns sw - CONV ON/NUCL OFF
13. (Elec fuze) AWW-1 Controls:
    a. Pwr sel knob - READY (30 sec DC)
    b. AWW-1 option sel knob - SET
    c. HV DC red light - ON (after 30 sec)
14. (Elec fuze) AWW-4 Controls:
    a. Dim control - FULL CCW
    b. AWW-4 function switch - SET
    c. HV DC light - ON

15. At IP, bomb button - DEPRESS HOLD

WARNING

Do not depress the bomb release button with the AFCS engaged, the bomb control switch in LABS, and the aircraft in a bank attitude. The aircraft immediately rolls in the direction of the bank. The outer roll gimbal of the gyros is caged when the bomb button is depressed causing an erratic signal to the autopilot.

a. Timer starts and the ADI needles center.
b. Warning tone sounds 1 second before steady tone.

16. At pullup point - FULL MIL POWER
    a. LABS light - ON
    b. Steady tone - ON
    c. Fly to center vertical and horizontal needles. (4.0 G in 2 sec)
17. At first bomb release:
    a. LABS light - OFF
    b. Steady tone - OFF
    c. Vertical needle - OUT OF VIEW
18. At last bomb release:
    a. Bomb button - RELEASE
       AJB-3, -7 reverts to all attitude.
    b. Wing-over escape maneuver - INITIATE

WARNING

Do not execute a roll-ahead recovery. A wing-over recovery, effecting at least a 90° heading change, provides the best airplane-bomb separation.

(U) EMERGENCY BOMB RELEASE FROM MER/TER

1. Bomb control sw - DIRECT
2. CONLABS sw - CONLABS OFF (Non-AFC modified aircraft only)
3. Center sta sw - SAFE (Non-AFC modified aircraft only)
4. Wpn sel knob - BOMB/RIPPLE/CLUSTER
5. Repeat steps 8 thru 15, hold bomb button depressed 4 sec.

Note

When releasing bombs armed, ensure minimum release interval is observed for the fuzes and bombs employed.

6. AWW-4 Analysis/Emergency Procedure:
   a. AWW-4 Function switch - NOT IN SAFE
   b. Press-to-test lamp.
      (1) If lamp lights, perform step c.
      (2) If no light, AWW-4 is inoperative and fuze will dud, or only the lamp is burned out and the fuze will arm.
   c. Press HVDC TEST button.
      (1) If lamp lights, depress and hold HVDC TEST button while depressing the bomb release button; fuze will arm.
      (2) If no light, AWW-4 is inoperative; fuze will dud.

NEW NEW NEW NEW

(U) Inflight Rehoming (MER/TER)

1. Wpn sel knob - RKT DISP
2. Wpn sel knob - AS DESIRED
3. Step reset sw - RESET (if necessary)

JETTISON SYSTEM

(U) DESCRIPTION

(U) Jettison capability exists from all nine external stores stations. Jettison from wing stations cleans the wings at the station by releasing the store(s) and suspension equipment, including pylons, as a single unit. Jettison from the centerline station releases the store(s) and all suspension equipment below the Aero 27/A rack. Jettison of fuselage mounted missiles ejects the missiles from the missile wells without firing the missile motor. Simultaneous jettison from all stations can be accomplished by the external stores emergency release button. Selective jettison from stations 1 and 9 can be performed by the external tanks jettison switch. Selective jettison from stations 2, 3, 4, 6, 7, or 8 can be performed by the selective missile jettison switch. Also, simultaneous jettison from stations 2, 3, 4, 6, 7 and 8 can be accomplished by the ALL position of the selective missile jettison switch on some airplanes. Air-to-air missile jettison, except in combination with other stores (stations), is not covered in this manual. For complete description of air-to-air missile jettison, refer to NAVAIR 01-245FDB-1A for F-4B/N or NAVAIR 01-245FDD-1A for F-4J. Selective centerline jettison is accomplished through the normal centerline release circuits.

(U) EXTERNAL STORES EMERGENCY RELEASE BUTTON

(U) The external stores emergency release button (panic button) is on the left vertical panel in the front cockpit (figure 2-6). Pushing the button will jettison stores from all stations, (1 thru 9), provided the landing gear handle is up or the weight of the aircraft is off the left main landing gear (figure 2-7).

Note

In aircraft 148363f thru 149474k before ASC 78, 87, and 97, no safety switch is installed on the left main landing gear, and only the landing gear handle in the up position makes the external stores emergency release button operative.

(U) On airplanes 158355at and up and all others after AFC 506, the jettison select switch limits the external stores jettisoned by the external store emergency release button.

(U) Jettison Select Switch

(U) On airplanes 158355at and up and all others after AFC 506, the jettison select switch (figure 2-1, sheet 2) is on the air-to-air panel in the front cockpit. The switch is used to retain all air-to-air weapons while jettisoning the remaining external stores when the external stores emergency release button is depressed, (see figure 2-7). The jettison select switch has three positions; ALL, AIR-GRD, and AIR-GRD+CL. In ALL, the external stores emergency release button jettisons all pylons, missiles and the centerline. In AIR-GRD+CL, all air-to-air missiles are retained while pylons and centerline are jettisoned. In AIR-GRD, all air-to-air missiles and centerline are retained while the pylons are jettisoned.

(U) With any combination of air-to-air missiles and other stores on either or both *inboard wing* stations and either AIR-GRD or AIR-GRD+CL selected on the jettison select switch, the inboard pylons will not be jettisoned when the external stores emergency release button is depressed. When a TER/PMBR and missiles are carried on either or both inboard wing stations, the stores carried on the TER/PMBR stations will automatically be bombed off (released) unarmed.

Note

The stores carried on the TER (or PMBR) are released simultaneously from the inboard stations (pairs) at the rate selected by the INTVL switch (.06, .100, .140 SEC). Bombs are released SAFE regardless of the arm nose tail switch position. The bomb rack arming solenoids are automatically deenergized, and the RKT DISP mode is automatically de-selected. A time delay relay is energized when the external stores emergency release button is depressed (if either AIR-GRD or AIR-GRD+CL is selected) to retain the bomb release power for 60 seconds.

(U) EXTERNAL TANKS JETTISON SWITCH

(U) The external tanks jettison switch is on the fuel panel in the front cockpit (figure 2-6). When the switch is placed from NORM to JETT, the pylons on stations 1 and 9 are jettisoned (figure 2-7). The safety interlocks (gear handle, left main gear scissors switch and the armament safety override button) are not in the circuit. The pylons can be jettisoned anytime electrical power is on the aircraft. The cover guard holds the switch in NORM position and is safety wired (F-4J 153780ac and up) to prevent accidental movement of switch.

(U) SELECTIVE MISSILE JETTISON KNOB

(U) The selective missile jettison knob is on the missile status panel in the front cockpit (figure 2-6). Stations 2, 3, 4, 6, 7, and 8, or all six stations can be selected for jettison by rotating the knob to the proper position: L WING (sta. 2), L AFT (sta. 3), L FWD (sta. 4), R FWD (sta. 6), R AFT (sta. 7), R WING (sta. 8), or ALL (stas. 2, 3, 4, 6, 7, and 8). The selected store(s) are then jettisoned by pushing the button in the center of the knob (figure 2-7). For complete details to jettison air-to-air missiles, see applicable manual. The ALL position is removed on F-4J 153900af and up, and all other F-4J and F-4B after AFC 346; however, in aircraft 148363f thru 153899af after AFC 346 and F-4N, the former ALL position can be used to jettison station 7 (R AFT). In aircraft 153900af and up, the former ALL position does not jettison station 7 nor any other station. The safety interlocks (gear handle, left main gear scissors switch and the armament safety override button) are not in the circuit. The pylons/missiles can be jettisoned anytime electrical power is on the aircraft.

(U) CENTERLINE JETTISON

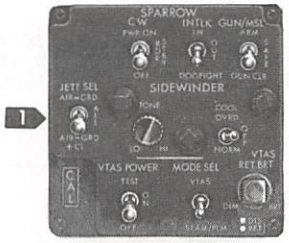
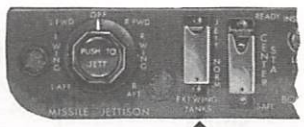
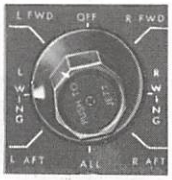
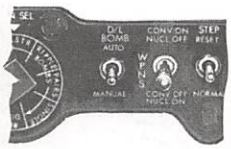
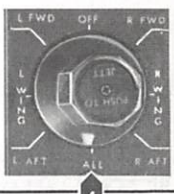
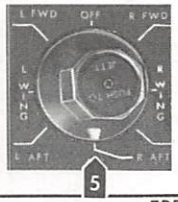
(U) To jettison stores from station 5, the normal centerline release circuit is utilized. The applicable controls (figure 2-6) are the centerline station switch and the bomb control switch on the bomb control panel, the weapons switch on the weapons control panel, and the bomb release button on the control stick. Pressing the bomb release button after making the following switch settings will jettison from station 5: centerline station switch to READY, bomb control switch to DIRECT and weapons switch to CONV OFF - NUCL ON (figure 2-7). The centerline release circuit is inoperative unless the landing gear handle is up. The landing gear handle safety provision can be overridden to make the centerline release circuit operative by depressing the armament safety override button.

Note

The following jettison switches were incorporated or their nomenclature changed by technical directives in early aircraft: centerline station switch added by ASC 87, master arm switch added by ASC 78 part I (SAFE position used for jettison), master arm switch nomenclature changed to weapons switch (and SAFE position changed to CONV OFF - NUCL ON) by AFC 241. In aircraft without one or more of the above changes, the jettison procedure is the same as described in this paragraph but with the applicable switch left out.

JETTISON CONTROLS

1. F-4J 158355at & UP, AND ALL OTHERS AFTER AFC 506, A JETTISON SELECT SWITCH IS ADDED AND THE EXTERNAL WING TANKS SWITCH IS RELOCATED. ALSO, WITH MISSILES ON EITHER AIRCRAFT STATION 2 OR 8 IN COMBINATION WITH A TER/PMBR INBOARD, ONLY THE STORES FROM THE TER/PMBR ARE RELEASED WHEN THE JETTISON SELECT SWITCH IS IN AIR-GRD OR AIR-GRD+ CL.
2. GEAR HANDLE UP OR ARMAMENT SAFETY OVERRIDE BUTTON IN.
3. AN ELECTRICAL INTERLOCK PREVENTS THE FWD TWO AERO 7A LAUNCHERS FROM FIRING WHEN A FUEL TANK OR MULTIPLE EJECTOR RACK IS MOUNTED ON THE CENTER LINE STATION.
4. ALL POSITION USED ON F-4B/N AND F-4J 153071z THRU 153899af BEFORE AFC 346.
5. F-4B/N AND F-4J 153071z THRU 153899af AFTER 346, FORMER ALL POSITION JETTISON'S R AFT. F-4J 153900af AND UP, FORMER ALL POSITION IS TOTALLY INOPERATIVE.

JETTISON:	SWITCH – POSITION	LOCATION
1 ALL EXCEPT MISSILES & ℄	1. JETTISON SELECT -AIR-GRD 2. EXT STORES EMER REL -PUSH	 1
1 ALL EXCEPT MISSILES	1. JETTISON SELECT -AIR-GRD+CL 2. EXT STORES EMER REL -PUSH	
ALL	1. JETTISON SELECT -ALL 1 2. EXT STORES EMER REL -PUSH	
OUTB'D WING PYLONS	EXT TANKS -JETT	 1
INB'D PYLONS	1. JETT KNOB -L OR R WING 2. JETT KNOB -PUSH	
2 CENTERLINE	1. BOMB CONTROL -DIRECT 2. CENTER STA -READY 3. WPNS-CONV OFF/NUCL ON 4. BOMB BUTTON -DEPRESS	
3 INB'D PYLONS AND FUS. MISSILES	1. JETT KNOB -ALL 2. JETT KNOB -PUSH	 4  5

UNCLASSIFIED

FDB-1T-(102)

Figure 2-6 (U)

JETTISON CIRCUIT-SIMPLIFIED — ALL STATIONS (Panic Button)

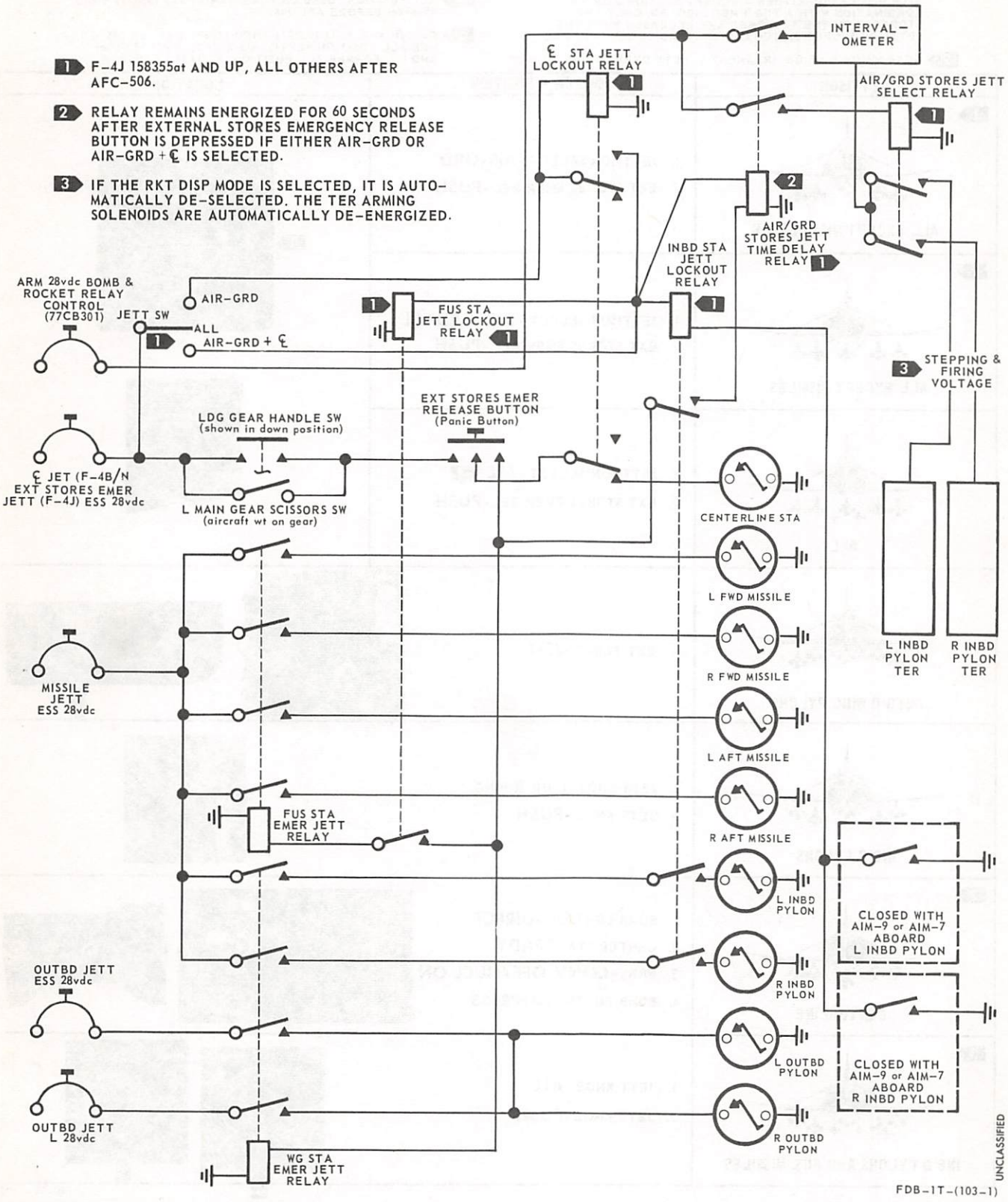
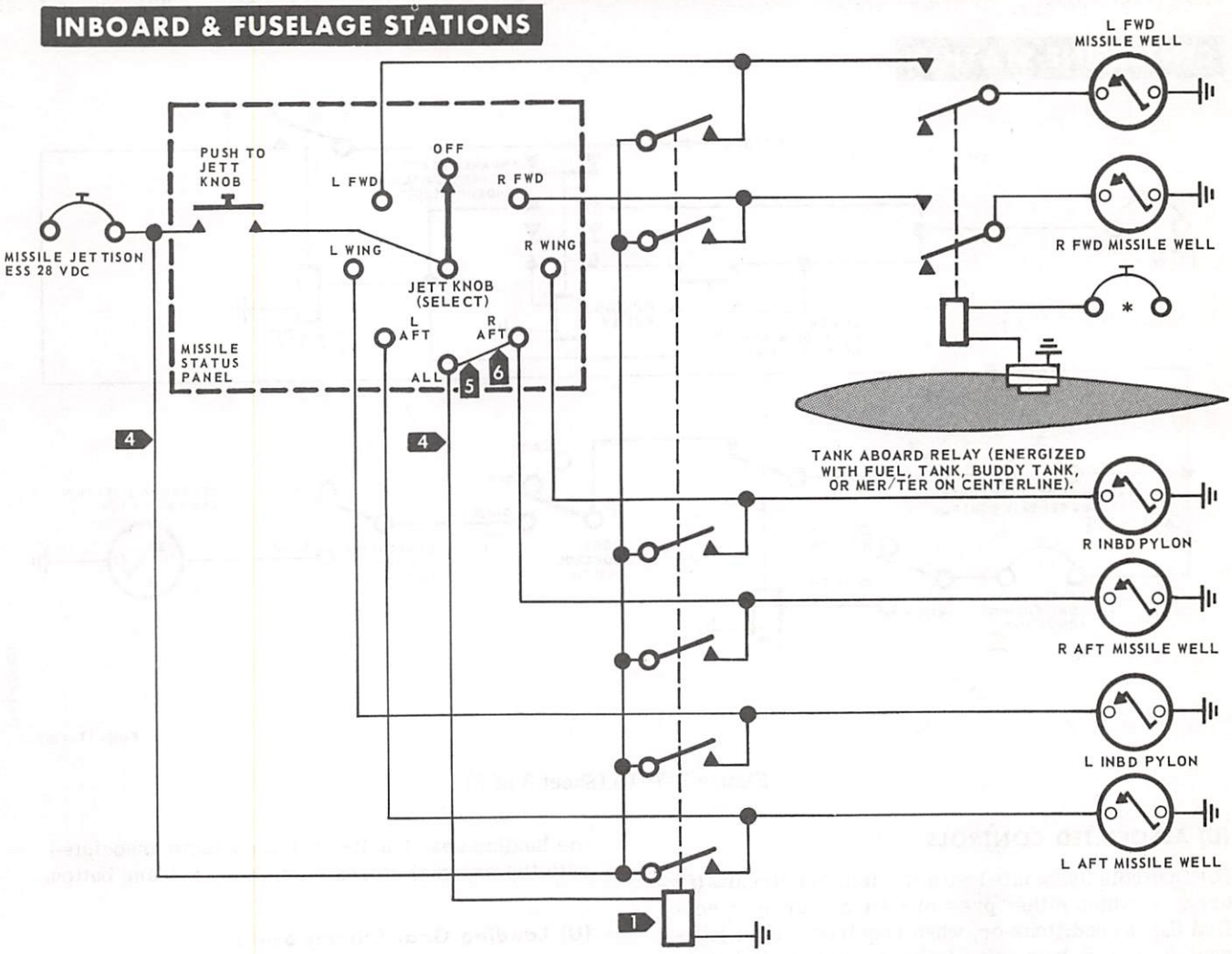


Figure 2-7 (U) (Sheet 1 of 3)

JETTISON CIRCUIT-SIMPLIFIED (CONTINUED)

INBOARD & FUSELAGE STATIONS



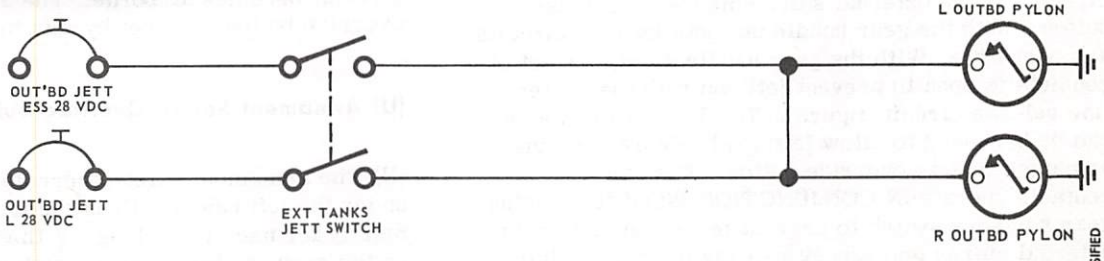
4 ALL JETTISON CAPABILITY REMOVED FROM 153900af AND UP AND F-4N, AND ALL OTHERS AFTER AFC 346 (WIRES REMOVED).

5 R AFT JETTISON CAPABILITY BY SELECTION OF FORMER ALL POSITION ADDED IN 148363f THRU 153899af AFTER AFC 346 AND F-4N (WIRE CONNECTING ALL AND R AFT ADDED).

6 FORMER ALL POSITION INOPERATIVE 153900af AND UP (WIRE CONNECTING ALL AND R AFT REMOVED).

* (F-4B/N) MISSILE FAIRING L 28 VDC
(F-4J) RADAR MISSILE FAIRING R 28 VDC

OUTBOARD STATIONS



UNCLASSIFIED

FDB-1T-(103-2)

Figure 2-7 (U) (Sheet 2 of 3)

JETTISON CIRCUIT-SIMPLIFIED (CONTINUED)

CENTERLINE STATION

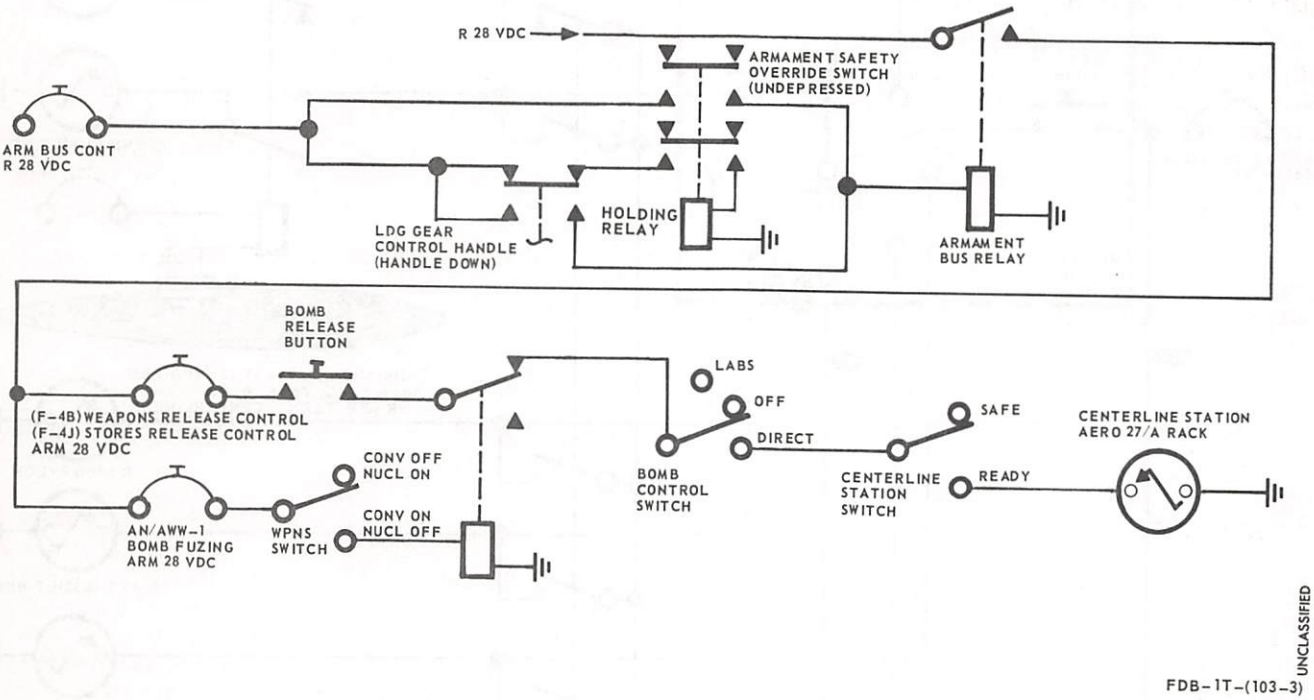


Figure 2-7 (U) (Sheet 3 of 3)

(U) ASSOCIATED CONTROLS

(U) Controls associated with the jettison circuits (figure 2-7) which either prevent jettison during specified flight conditions or, when required, aid in jettisoning through bypassing jettison safety switches, are the landing gear handle safety switch, the landing gear scissors switch and the armament safety override button.

(U) Landing Gear Handle Safety Switch

(U) The safety switch within the landing gear handle contains two sets of contacts which affect the operation of the centerline release (and centerline jettison) circuit and the external store emergency release button. With the gear handle up, both jettison circuits are operative. With the gear handle down, one set of contacts is open to prevent jettison with the centerline release circuit (figure 2-7). The open contacts can be bypassed to allow jettison by depressing the armament safety override button. The other set of contacts operate IN CONJUNCTION WITH the landing gear scissors switch to prevent jettisoning using the external stores emergency release button. With the landing gear handle down, the contacts open to deny power to the external stores emergency release button, provided the weight of the aircraft is on the left main landing gear (scissors switch open) (figure 2-7). The armament safety override button does not bypass the landing gear handle switch contacts associated with the external stores emergency release button.

(U) Landing Gear Scissors Switch

(U) The landing gear scissors switch on the left main landing gear, in conjunction with the landing gear handle safety switch, prevents jettison by the external stores emergency release button. With the weight of the aircraft on the main landing gear and the landing gear handle down, the scissors switch is open to deny power to the external stores emergency release button (figure 2-7). The switch closes as soon as the aircraft becomes airborne. The armament safety override button does not bypass the scissors switch.

(U) Armament Safety Override Button

(U) The armament safety override button (figure 2-1) under the left canopy sill in the front cockpit is primarily for use in checking out the bombing circuits on the ground. However, it can be used to bypass the landing gear handle safety switch to provide power to the armament bus for the centerline jettison circuit (figure 2-7) and for the multiple weapons release circuit. Refer to Armament Safety Override Button, Multiple Weapons Release System, this Part.

(U) NORMAL OPERATION

(U) The following procedures are presented in the Tactical Manual Pocket Guide, NAVAIR 01-245FDB-1T(B).

(U) EMERGENCY JETTISON

(U) F-4B/N & F-4J thru 158354as before AFC 506, with landing gear handle up or weight off the gear, perform the following:

1. External stores emergency release button - PUSH.

(U) F-4J 158355at and up, and all others after AFC 506, with landing gear handle up or weight off the gear, perform the following:

1. Jettison selector switch - ALL
2. External stores emergency release button - PUSH

(U) SELECTIVE JETTISON

(U) Centerline Station

1. Bomb control switch - DIRECT
2. Center station switch - READY
3. Weapons switch - CONV OFF - NUCL ON
4. Bomb button - DEPRESS

(U) Outboard Wing Stations

1. Wing station jettison switch - JETT

(U) Inboard Wing Stations

1. Missile jettison knob - L or R WING
2. Missile jettison knob button - PUSH

(U) ADDITIONAL SELECTIVE JETTISON

(U) F-4J 158355at and up, and all others after AFC 506.

(U) Outboard and Inboard Wing Stations

1. Jettison selector switch - AIR-GRD
2. External stores emergency release button - PUSH.

(U) Outboard, Inboard Plus Centerline Stations

1. Jettison selector switch - AIR-GRD+CL
2. External stores emergency release button - PUSH

(U) EMERGENCY OPERATION (CENTERLINE)

(U) If selective jettison from the centerline station fails due to a failure in the landing gear handle safety switch, the safety switch can be bypassed by depressing the armament safety override button (figure 2-7). Therefore, if normal jettison from the centerline fails, attempt jettison by depressing and holding the armament safety override button simultaneous with normal jettison procedure.

(U) LIMITATIONS

(U) Refer to External Stores Limitations, Appendix A.

SUSPENSION EQUIPMENT

(U) DESCRIPTION

(U) The suspension equipment (figure 2-8) used to suspend and release conventional bombs and rockets from the aircraft includes the following:

a. Outboard, wing tank pylon, plus:

(1) Wing tank pylon adapter.
(2) Multiple ejector rack (MER), or triple ejector rack (TER), or practice multiple bomb rack (PMBR).

b. Inboard, LAU-17/A wing missile pylon, plus:

(1) LAU-17A wing missile pylon adapter.
(2) Triple ejector rack (TER), or practice multiple bomb rack (PMBR).

c. Centerline, Aero 27A bomb rack, plus:

(1) Centerline MER adapter, or practice multiple bomb rack (PMBR).
(2) Multiple ejector rack (MER), or triple ejector rack (TER).

SUSPENSION EQUIPMENT

MULTIPLE WEAPONS SAFETY PINS

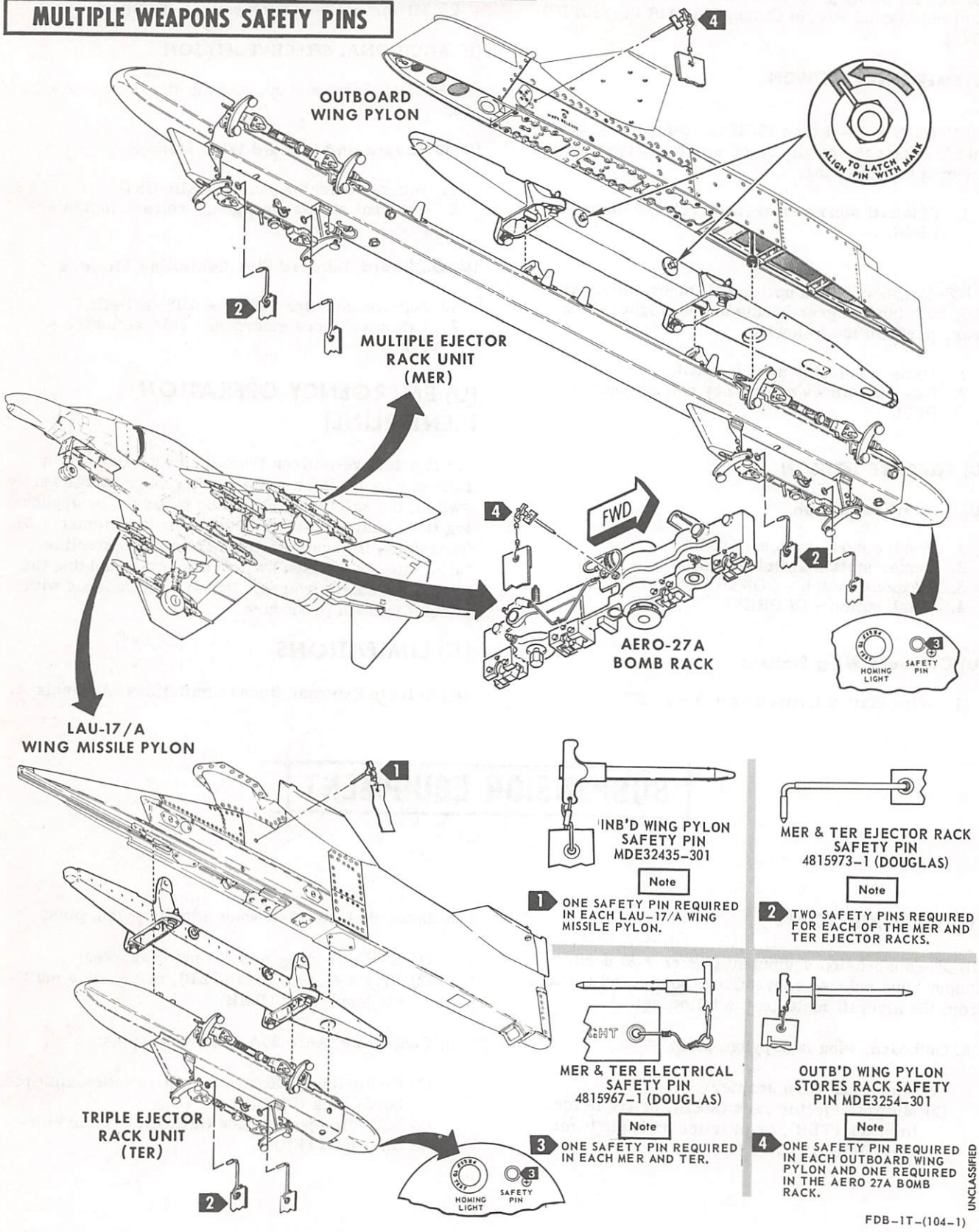


Figure 2-8 (U) (Sheet 1 of 4)

SUSPENSION EQUIPMENT-CONTINUED

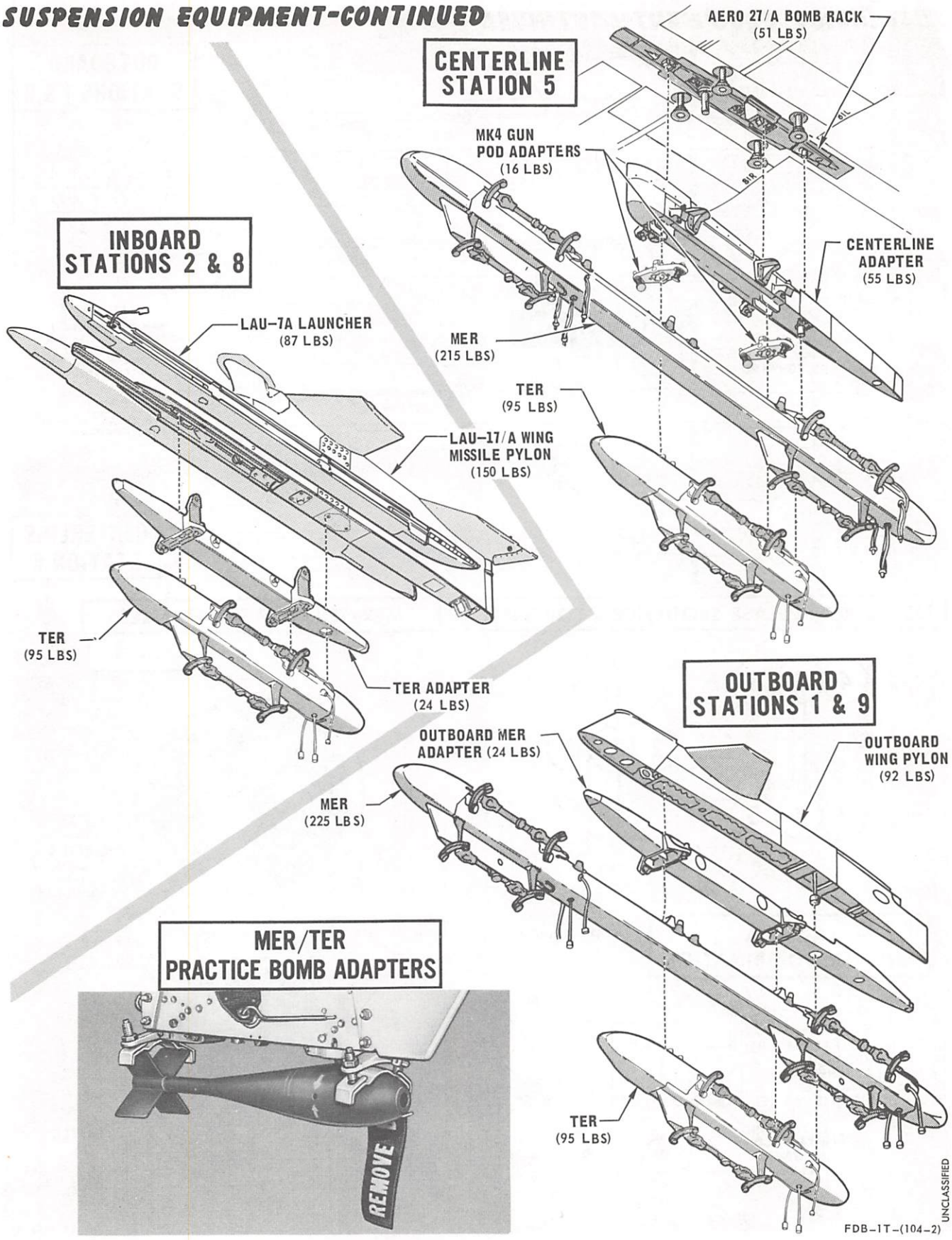
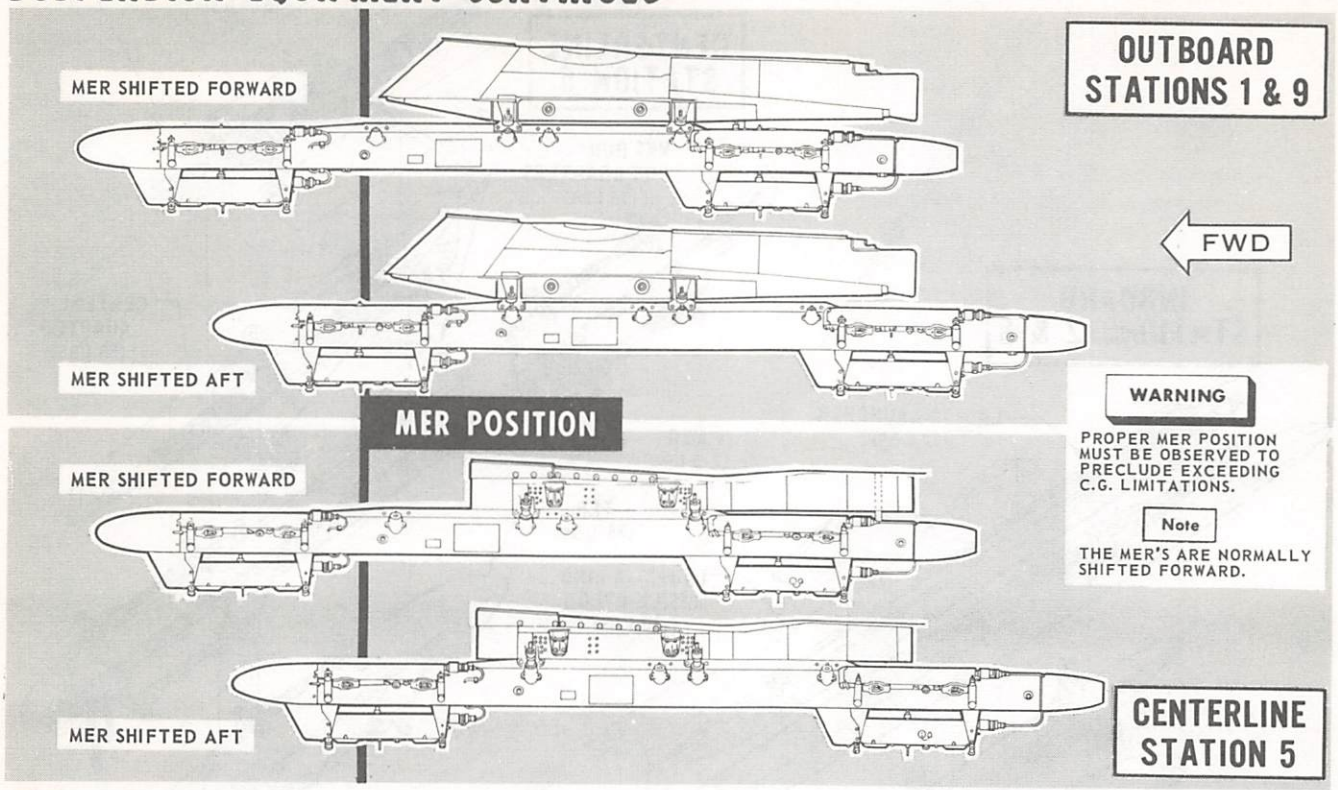
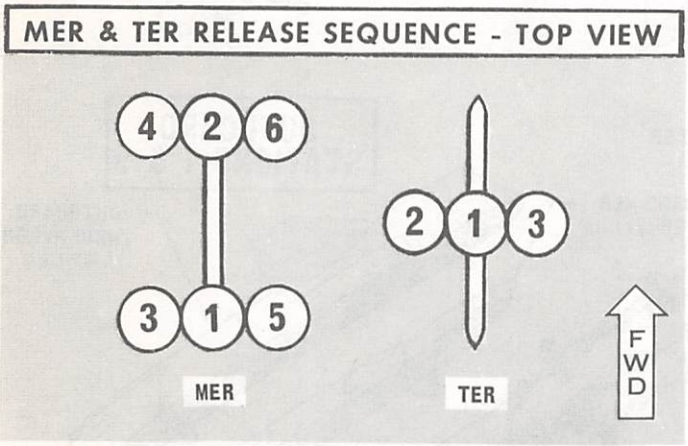
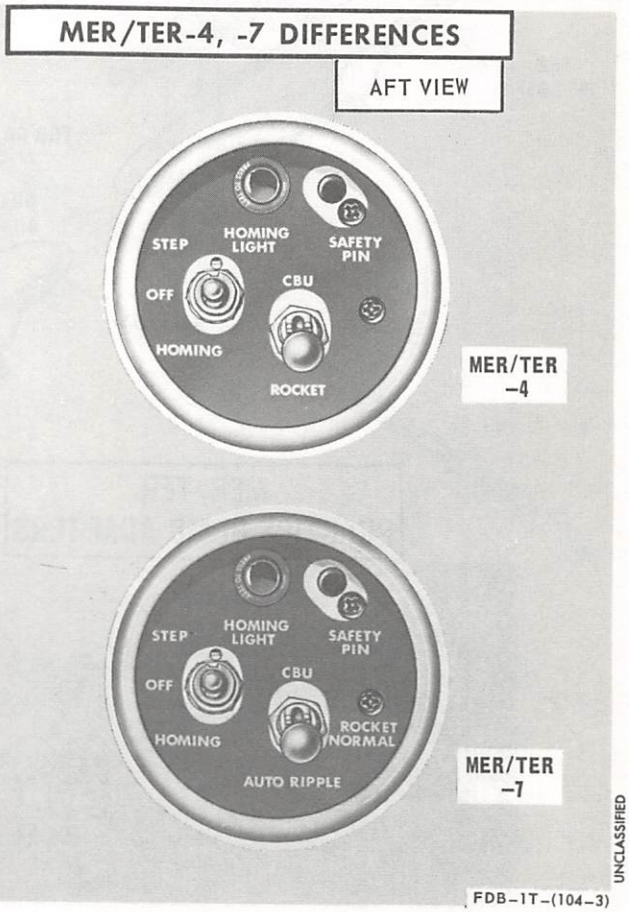


Figure 2-8 (U) (Sheet 2 of 4)

SUSPENSION EQUIPMENT-CONTINUED







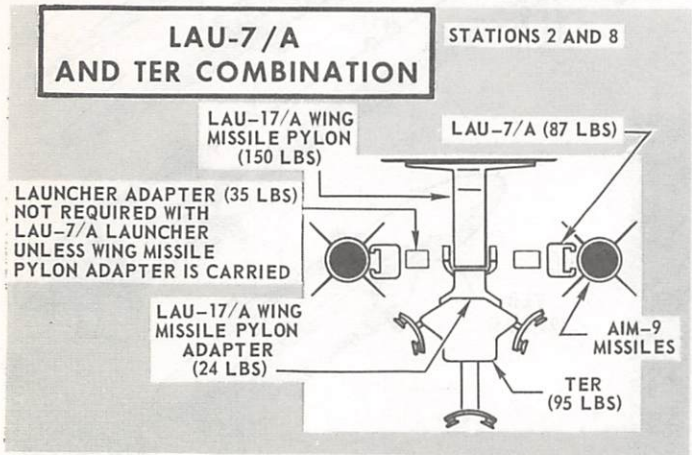


Figure 2-8 (U) (Sheet 3 of 4)

SUSPENSION EQUIPMENT-CONTINUED

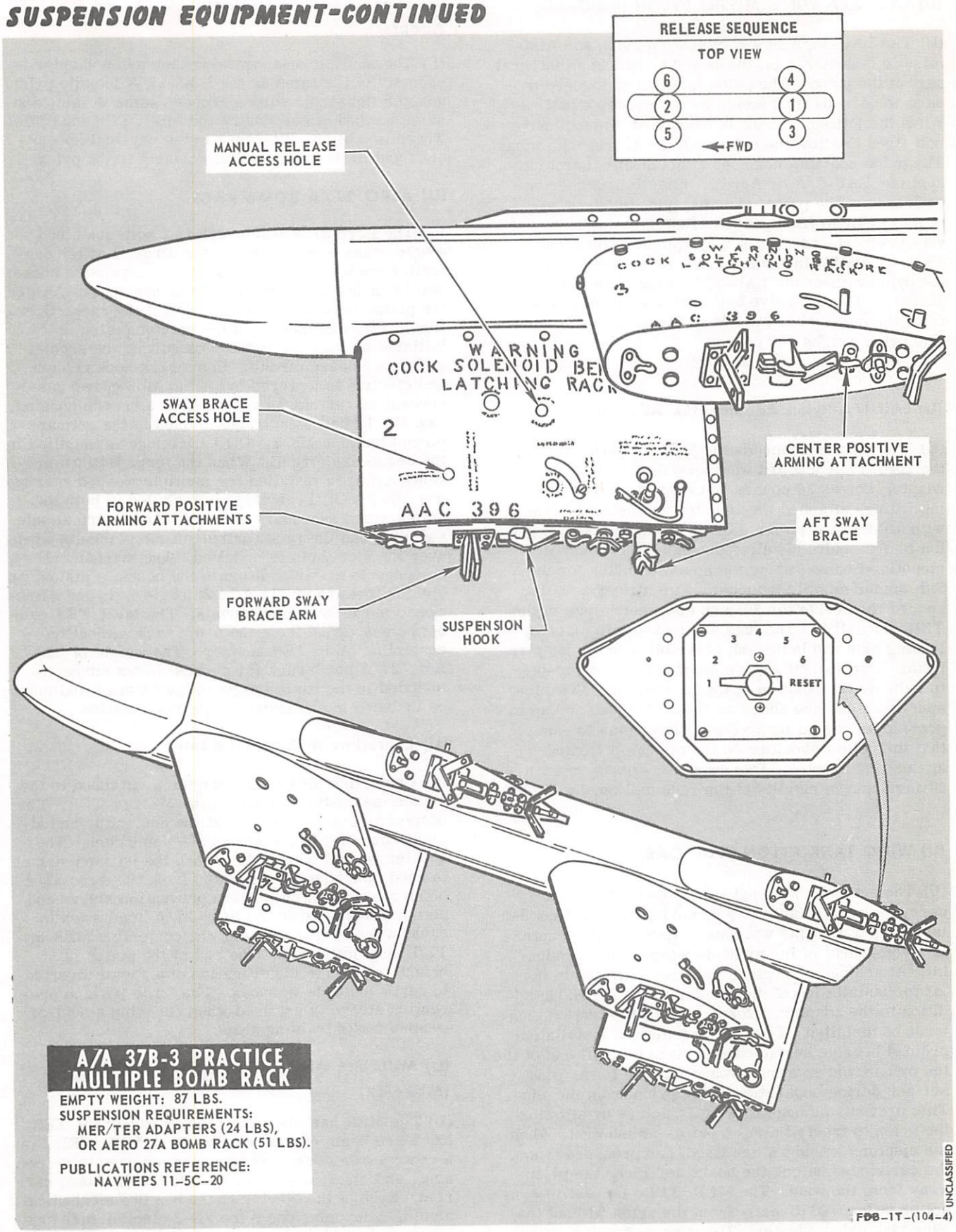


Figure 2-8 (U) (Sheet 4 of 4)

(U) LAU-17/A WING MISSILE PYLON (INBOARD)

(U) The LAU-17/A is a combination pylon and AIM-7 missile launcher; i.e., the launcher rail is an integral part of the pylon. The pylon is attached inboard on each wing (stations 2 and 8) by an explosive bolt. When the jettison circuit is energized, the explosive bolt fires to allow the pylon to freefall from the wing. The pylon contains launcher attachment points to accept one LAU-7/A or Aero 3A missile launcher on each side of the pylon. A safety pin, which is removed prior to flight, is installed in the pylon to prevent inadvertent firing of the explosive bolt. The TER and PMBR launcher cannot be suspended from the pylon without the LAU-17/A wing missile pylon adapter. The explosive bolt cartridge is removed from the pylon when the PMBR launcher is aboard. The pylon weighs 150 pounds.

(U) LAU-17A Pylon Adapter (TER Adapter)

(U) The adapter suspends the TER or PMBR from the LAU-17/A inboard wing missile pylon. The adapter weighs 24 pounds and consists of two mounting fittings attached together by a structural beam with a fairing at either end. It is attached to the pylon by four bolts installed through the fwd and aft mounting fittings, using the mounting holes for the Sidewinder missile launcher. The fittings are also spaced to receive the 30-inch suspension lugs of the TER and PMBR. The lugs are locked into place by locking pins and bellcrank assemblies in the adapter beam. Two indicators are provided on each adapter to indicate the position of the locking pins. Two inspection holes are added on F-4J 154786ag and up to provide for visual inspection of latch pins to ensure that the yellow shoulder on the pin has bottomed against the adapter. Two swaybrace posts on each fitting assures rigidity of the rack unit during flight.

(U) WING TANK PYLON (OUTBOARD)

(U) The outboard wing pylon may be converted to carry multiple weapons by removing the fuel tank and installing a multiple weapons adapter. This adapter is a component of the multiple weapons conversion kit. Attaching components are also provided in the kit for installation of the adapter to the pylon. In addition to the adapter, a force jettison prevention plug must be installed. The plug provides an installation preload bearing surface and prevents the aft end of the the pylon from rotating upward into the lower wing surface during separation of the pylon from the wing. This prevents damage to wing structure by allowing the pylon to freefall away from its attachment. When the ejector cartridges are fired, gas pressure from the cartridges unlock the hooks and force the pylon away from the wing. The MER, TER, and PMBR cannot be suspended directly from the pylon without the wing tank pylon adapter. The wing tank pylon weighs 92 pounds.

(U) Wing Tank Pylon Adapter (Outboard MER/TER Adapter)

(U) The multiple weapons wing tank pylon adapter is essentially the same as the LAU-17/A missile pylon adapter (inboard), same purpose, same weight, and same method of suspending the MER, TER and PMBR. There is a slight difference in the physical appearance and in the method of attachment to the pylon.

(U) AERO 27/A BOMB RACK

(U) The Aero 27/A bomb rack is a self-contained ejector rack mounted within the aircraft at the centerline station. The rack has four suspension hooks; two 14 inches apart and two 30 inches apart. An ejector piston is located in the center of the rack. Operation of the rack hooks and the ejector piston is initiated through the jettison circuit or the special weapons release circuit. Bomb rack hook release and ejection is powered by the ignition of two gas generating cartridges contained in a breech housing. One MK 1 MOD 3 cartridge is used in the primary circuit and one MK 2 MOD 1 cartridge is installed in the secondary circuit. When the force jettison prevention plug is installed for multiple weapon carriage, one MK 2 MOD 1 cartridge is installed in both the primary and secondary circuits. An electrical safe switch opens the rack cartridge firing circuits whenever the safety pin is installed. The mechanical components are in addition to the hooks; a piston, an ejector foot assembly, a hook toggle rod, and a linkage to move these components. The MER/TER cannot be suspended from the bomb rack without the centerline MER/TER adapter. The weight of the Aero 27/A bomb rack (51 pounds) is not currently included in the basic weight of the aircraft and must be included in any gross weight computation.

(U) Centerline MER/TER Adapter

(U) Centerline MER/TER adapter is attached to the centerline position to accept the MER or TER. The adapter is compatible only at the centerline and attaches directly to the Aero 27/A bomb rack. The adapter weighs 55 pounds. When the jettison circuit is used, the adapter separates from the Aero 27/A bomb rack. A force jettison prevention sleeve and piston is installed in the Aero 27/A bomb rack to cause a free-fall release of the centerline MER or TER when jettisoned. The end of the piston is bright orange for identification of a rack converted to carry multiple weapons. The force jettison prevention sleeve is not used when carrying a nuclear weapon or its training shape.

(U) MULTIPLE AND TRIPLE EJECTOR RACKS (MER/TER)

(U) The MER has six bomb ejector racks; the TER has three bomb ejector racks. Each MER/TER has a control panel, and the circuitry required to select, arm, and eject, dispense, or fire the ordnance carried. Each of the ejector racks has two mechanical arming solenoids, one Aero 2B-1 electric fuze arming unit, two 14-inch suspension lugs, one ejector foot, a store-aboard sensing switch, and two safety

pins that must be removed prior to flight. The ejector racks are numbered in the order of the fixed release sequence, figure 2-3, Normal Release Sequence.

(U) The MER can be suspended from the outboard wing tank pylons and the centerline Aero 27A bomb rack (stations 1, 5, and 9) when coupled to a MER adapter. The TER can be suspended from all five aircraft weapon stations (1, 2, 5, 8, and 9) when coupled to an adapter. The MER/TER suspension lugs are 30 inches apart. The MER lugs can be relocated to permit a forward or aft MER position. The position of the MER (shifted forward or aft) is stated in the external store limitations chart, appendix I. The TER has one position and cannot be shifted.

(U) PRACTICE MULTIPLE BOMB RACK (PMBR)

(U) The A/A37B-3 PMBR carries and releases up to six practice bombs. The PMBR components consist of a wire bundle assembly, intervalometer, two suspension lugs and six practice bomb carrying stations, each with a solenoid, hook, and forward and aft sway-brace. The PMBR may be installed on the centerline station (Aero 27A), LAU-17/A pylon and outboard wing pylon. The force jettison prevention sleeve and piston of the MER and TER Conversion Kit (32-90701) must be installed in the Aero 27A bomb rack. The force jettison prevention plugs, outboard and inboard adapters of the Multiple Weapons Conversion Kit (32-90700) must be installed on the LAU-17/A and outboard wing pylons prior to the installation of PMBR. The aircraft multiple weapons release system is utilized for weapons release. The practice bombs are released free-fall (not ejected) from the PMBR. Conversion kit 64A81C111-1 is required to adapt the PMBR to the F-4B/J/N aircraft.

(U) NORMAL OPERATION

(U) MULTIPLE AND TRIPLE EJECTOR RACKS OPERATION

(U) The basic mechanical components and electrical systems are essentially the same in both the multiple and triple ejector racks. The main difference between the two racks is that the multiple ejector rack has six ejector units and the triple ejector racks have three. There are two arming solenoids on each ejector unit whose function is to retain the nose and tail bomb arming wire swivel and loop assembly, or arming lanyard, upon release of the stores. These solenoids are controlled by the Nose/Tail Arm switch on the weapons control panel. The Nose/Tail Arm switch also directs electrical power to the sensing switch to step the stepper switch.

(U) When the WPN SEL switch is in the BOMBS position, an intervalometer pulse enters the ejector rack and energizes the step relay. The pulse also passes through the deenergized rocket select relay and the bomb release portion of the stepper switch to the individual ejector units. The stepper switch will step to the next ejector unit when the bomb release button is released. If the next ejector unit is not loaded, the sensing switches on the ejector units will continue to step the stepper switch until a loaded ejector unit is found (hooks closed). If no ejector unit is loaded, the stepper switch will be stepped to one position beyond the last firing position. At this position the transfer portion of the switch loses electrical ground allowing a transfer relay in the adapter bundle to open, thus preventing the next intervalometer pulse from entering that wing station.

(U) If the WPN SEL switch is positioned to ALL, the next intervalometer pulse will automatically move from the outboard to inboard wing stations and then to the centerline station. When the WPN SEL switch is positioned to RKT DISP, the select rockets relay is energized directing the intervalometer pulse through the rocket release portion of the switch to be distributed to the rocket packs. The stepper switch will step to the next ejector unit when the bomb release switch is released. If no other ejector unit is loaded, the stepper switch will step around to and past the home position to the original ejector unit. This is possible because 28 vdc is supplied through the energized rockets select relay to the stepper switch. Because the stepper switch always seeks a loaded ejector unit when WPN SEL switch is in the RKT DISP position it is not possible, with STA SEL switch in the ALL position, to automatically transfer the firing pulse from one wing station to the other. With new wire bundle assembly, part No. 32-94729, automatic station transfer to the INBOARD station and then to the CENTERLINE station is available.

WARNING

AAC 492 removes the plunger type store-aboard sensing switch and locates it in the forward ejector rack hook. Refer to External Store Limitations, appendix I, to determine, if the hooks must be open or closed on the empty stations. This affects the release sequence and the time interval between bombs released.

(U) Bomb release interval is affected by AAC 492 to MER/TER-4, and a modification to centerline wire bundle. The modified centerline cable No. 32G94729 doubles the bomb release interval selected by the interval switch. When BOMBS SINGLE or BOMBS RIPPLE release mode is used and with 0.100 second interval selected, the bomb release interval from centerline is 0.200 second. When BOMBS PAIRS or BOMBS CLUSTER release mode is used and 0.100 second interval is selected, the bomb release interval from centerline is 0.100 second. AVC 492 relocates the store aboard sensing switch where it is actuated by the forward hook on the MER/TER-4. The sensing switch on the MER/TER-7 is also actuated by the forward hook. A release pulse is directed in sequence to the loaded station or where the forward hook is closed. The MER/TER stepper switch steps to the next station at pulse completion (23 to 33 milliseconds). (Ejector cartridges are never installed on any empty station.) The resulting release interval between bombs must be determined and considered when determining the bomb spacing and pattern

length. The External Stores Limitations chart, Appendix I, indicates that some load configurations require certain MER/TER station hooks be closed.

Note

A store released from the MER/TER has an ejection velocity imposed by the ejector foot. Zero ejection velocity (free fall) can be obtained by removing the ejector foot from the MER/TER. Free fall release is required for some practice bombs. The ejection velocity for each weapon is stated on the Sight Angle charts, part 4 of this section.

(U) MER/TER Rehoming

(U) Before AAC 509 to re-home the step switch within the MER or TER rack, the weapons selector switch must be momentarily positioned to RKT DISP and back to BOMBS. Before AAC 509, (Automatic Homing Capability for U.S.N. MER/TER-7 Rack) when using MER/TER-7 racks, the ALL position on the station selector knob will not permit automatic station transfer from outboard to inboard station if there is a hung store on the outboard station. If hung store is on the inboard station with ALL selected, automatic transfer to the centerline station will not occur. In addition, there is the possibility that station transfer will occur only momentarily and then switch back to the station with the hung store. If a release pulse is generated during the momentary transfer, a bomb will be released before the signal is transferred back to the station with the hung store.

(U) After AAC 509, with the ALL position selected, automatic station transfer will occur from the station with a hung store. The step reset switch must be positioned to RESET after power is applied to the aircraft to permit all of MER's and TER's to re-home to MER or TER station number one. To release a hung store with ALL stations selected, the step reset switch is positioned to RESET. Since the jumper cable provided with AAC 509 can be used with any MER/TER configuration, the pilot should always position the step reset switch to RESET before a bombing run and should include the step switch in the re-homing procedure after selecting RKT DISP to re-home the MER/TER's that do not have the auto-re-homing capability.

(U) To summarize: If the pilot does not know the MER/TER configuration, or which jumper cable is being used, and which AAC's have been incorporated, the pilot should:(1) include the use of the step reset switch in the re-homing procedure and (2) re-home the MER/TER before a bombing run.

Note

In aircraft with AAC 509, the step reset switch must be actuated after power is applied to the aircraft to obtain a weapon release from the MER and TER racks.

(U) EMERGENCY OPERATION

(U) There is no emergency operation other than the MER/TER re-homing procedure (refer to Normal Operation) and the jettison procedure (refer to Jettison System).

WEAPON SELECTION

(U) Weapon selection is a function of many variables, which include: aircraft configuration, launch and recovery limitations, aircraft carriage limitations, weapon and fuzing, target characteristics, mission purpose, and range to target. For weapon employment and effectiveness data, refer to NWIP 20-1, Com Seventh Fleet-Instructions PO3310.1, Air to Surface Weaponeering Handbook, or the Joint Munitions Effectiveness Manual. For fuze limitations and bomb/fuze compatibility, refer to Fuzing and Fuze Limitations, this part. Refer to appendix I for the external stores limitations of compatible weapons.

(U) Since this manual contains data on all fuzes and ordnance currently authorized for the F-4 aircraft, it is highly desirable that an individual squadron should become thoroughly familiar with the specific fuzes and ordnance that they are actually using. This data should be made available to affected personnel. In this way, possible errors induced by individual research and hasty planning would be eliminated. Even though portions of part 1 may be applicable to both F-4B/N and F-4J aircraft, only the F-4B/N aircraft is presently considered.

(U) The qualified load crew has available 3 1/2 by 5 1/2 inch, plastic coated checklist cards which the aircrew may find useful in performing weapon preflight check. One side has abbreviated load procedures, the other side has an illustration of the arming wire configuration and the various safety pins and preflight check points. These cards are kept current and each card is dated. The F-4 STORES RELIABILITY CARDS are listed in weapon description, part 4, and were used to prepare the Weapon Exterior Checks contained in the Tactical Manual Pocket Guide. NEW

FUZING AND FUZE LIMITATIONS

(U) BOMB FUZING

(U) GENERAL

(U) Proper selection of bomb fuzes is absolutely essential for safety of the delivery aircraft and effectiveness of the mission. Because mission requirements and weapons vary widely, it is necessary to maintain a number of different types of fuzes in stockpile, each fuze having its own delivery characteristics and imposing its own delivery requirements.

NEW NEW NEW NEW NEW

(U) Fuzes may be most conveniently divided into two categories: electrical and mechanical. Each has its own advantages and disadvantages. Electrical fuzes allow the use of VT devices and can provide the pilot with inflight selection of arming and functioning delays. The functioning time of an electric fuze, as compared to a mechanical fuze, is much more efficient, producing a truly instantaneous surface burst. This is a distinct tactical advantage when maximum fragmentation and minimum cratering is required. When used with a steel nose plug, electric fuzes permit much more efficient penetration of hard targets. Additionally, electric fuzes impose no maximum delivery or carriage speed restrictions. Electric fuzes however, are more prone to early burst on arming, are more sensitive to electromagnetic radiation (HERO), and increase the chance for pilot error in selection of various fuzing options. Mechanical fuzes are more reliable in operation but generally provide no inflight option of arming and functioning delays. Arming wires and arming vanes on mechanical fuzes impose various carriage and delivery restrictions.

(U) Pertinent characteristics of these types of fuzes are summarized below. Figure 2-9 provides a compatibility summary of authorized bomb/fuze combinations. Details of each fuze currently authorized for carriage are provided in the summary sheets (figures 2-11 thru 2-23). Rocket fuze data is contained in figures 2-24.

(U) MECHANICAL FUZES

(U) Most current mechanical fuzes contain the same basic elements and operate on a similar principle.

(U) Fuze Arming

(U) An arming vane on the fuze is driven by the air stream and provides mechanical energy to operate the fuze mechanism. This vane is held stationary while on the aircraft by an arming wire which extends through the blades of the vane and is connected to an arming solenoid on the bomb rack.

(U) If the weapon is to be released *armed*, the bomb rack solenoid is energized, thus locking the arming wire to the rack. Upon bomb release the arming wire is withdrawn from the fuze and the arming vane commences rotation. This rotation drives a gear train in the fuze which removes safety blocks and aligns the firing pin with a sensitive explosive detonator. The fuze is then considered *armed* and ready to function. The gear train mechanism is designed to provide a definite delay after separation from the aircraft. This is called *arming delay*.

(U) Some of the latest fuzes permit the selection of various arming delays prior to flight and also contain a governor mechanism so that arming delay time will remain constant throughout the range of release airspeeds.

(U) Fuze Functioning

(U) With most impact fuzes, the firing pin is driven into a detonator or primer on impact. This, in turn, initiates an explosive booster and detonates the main charge in the weapon.

(U) In airburst (time) fuzes, the firing pin is actuated by a preset clockwork mechanism rather than by impact.

(U) A short delay (functioning delay) between impact and detonation can be provided by the use of pyrotechnic elements. The delay element is integral to some fuzes and in others must be inserted in the fuze prior to installation in the bomb. For long delays (several seconds up to several hours) various methods are used including pyrotechnic, and clockwork. Selection of the proper functioning delay is necessary to maximize the effect of the bomb against various targets. The Joint Munitions Effectiveness Manual (JMEM) provides data on this subject.

(U) Safe-Jettison

(U) To safe-jettison a mechanical fuze, the bomb rack solenoid is not energized allowing the arming wire to remain in the fuze on weapon release. This keeps the arming vane locked and prevents the fuze from arming.

(U) In bomb racks used on jet aircraft, it has been necessary to increase the holding tension of the solenoid in the deenergized (SAFE) position. This prevents the highspeed air stream from pulling the arming wire from the solenoid. Under service use environment, this holding tension can further increase to the point where it is impossible to jettison a weapon in the SAFE condition regardless of the position of the nose tail arm switch. To minimize this possibility, maintenance and loading procedures outlined in current Technical Directives and Loading Manuals must be carefully observed.

(U) If an unarmed weapon impacts with sufficient velocity on a hard surface, a significant detonation can still occur, with bomb fragmentation hazard to the delivery aircraft. Therefore, if it is necessary to

BOMB/FUZE COMBINATIONS

CAUTION: This chart is intended for ready reference only. Users must refer to individual fuze Summary Sheets and Minimum Authorized Arming Times and Speeds chart for limitations and restrictions on specific combinations. Safe usage of most fuzes depends upon type of delivery and arming times selected.

FUZE		GENERAL USE STORES						
		LDGP			RETARD		GP	
NOSE FUZES	TYPE	MK 81	MK 82	MK 83	MK 81	MK 82	M117A1	COMMENTS
MK 347	M	A	A	X	A	A	X	Low speed, retarded delivery.
M904E2/E3/E4	M	A	A	A	A	A	A	
M1A1 FUZE EXTENSION (Daisy Cutter)	M	A	A	A	X	X	X	Use only with fuzes set for INST functioning delay.
VT ELEMENTS								
M20/20A1	E	A	A	A	X	X	A	Compatible with all electric fuzes. Can not be used without electric fuze.
MK 43	E	A	A	A	A	A	A	
TAIL FUZES								
MK 344	E	P	P	P	X	X	P	For dive delivery– unretarded.
MK 376	E	P	P	P	A	A	P	For ret. dive or unret. level delivery.
MK 346	M	A	A	A	A	A	X	Long delay.
M990E1/E3/E4	E	A	A	A	X	X	A	Not authorized for retarded delivery.

FUZE			SPECIAL PURPOSE STORES				
SPECIAL USE FUZES	LOCATION	TYPE	CBU 24/29/49	FIRE BOMB MK 77–4	MK 36, MK 40 DST	ROCKEYE II MK 20	LASER GUIDED BOMB MK 82
MK 13 Initiator	S	M	X	P	X	X	X
M918	S	M	X	A	X	X	X
MK 339	N	M	X	X	X	A	X
M907E1/E2	N	M	A	X	X	X	X
MK 32 Arming Device	N	M	X	X	A	X	X
MK 42 Firing Mechanism	T	E	X	X	A	X	X
MK 344/MK 376	T	E	X	X	X	X	A

KEY TO SYMBOLS

Fuze Type and Location
- M – Mechanical
- E – Electrical
- N – Nose
- T – Tail
- S – Side

Bomb Fuze Combinations
- A – Authorized
- P – Preferred usage
- X – Not Authorized

WARNING: THE ONLY FUZES AUTHORIZED FOR THERMALLY PROTECTED BOMBS ARE: M904E4, M990 SERIES, MK 344, MK 376, MK 32 ARMING DEVICE, MK 42 FIRING MECHANISM.

UNCLASSIFIED

FDB-1T-(105)

Figure 2-9 (U)

safe-jettison stores, bombs should be released over water or soft ground, at low airspeeds, and above the fragmentation envelope. These precautions are particularly applicable to nose fuzes due to their exposed location. Bombs may detonate on hard targets even without a fuze installed.

(U) Shear Safe

(U) In most modern fuzes, the firing pin and the detonator or primer are not aligned until the fuze arms. Should an unarmed fuze shear off the bomb on impact, the weapon will remain relatively safe. This provision greatly reduces the probability of bomb detonation in the event of a landing accident.

(U) ELECTRIC FUZES

(U) There are two basic types of electric fuzes. These are:

a. DC - Only preselected fuzes M990E-1, E-3 and E-4.
b. DC - Only retard sensing fuzes - MK 344 and MK 376.

(U) The MK 344/376 fuzes are being produced as replacements for the M990 series.

(U) Basic Theory of Operation

(U) While there are important differences between these fuzes which pilots must understand, the operating principles are similar.

(U) Electric fuzes receive their operating energy from the delivery aircraft via the Fuze Functioning Control Set, a bomb-rack cable assembly, and a cable network in the bomb. This energy is applied to the fuze during the first few inches of bomb travel after release from the bomb rack.

(U) For each arming/functioning delay combination provided by the fuze there is a discrete electrical circuit or channel in the fuze. Each of these channels is designed to provide a specific electrical delay when a voltage is applied.

(U) Preselected DC-Only Fuzes (M990 E1, E3, E4)

(U) These are basic +300 volt dc fuzes in which a single arming/functioning delay circuit has been preselected prior to issue. These fuzes need only dc voltage for their operation and no delay options are available to the pilot. Inadvertent application by the pilot of an rf signal or a dc voltage other than +300 v may cause unreliable operation or erratic arming delays.

(U) DC-Only Retard Sensing Fuzes (MK 344, MK 376)

(U) These fuzes use a deceleration sensing device to automatically select the proper arming delay time for either the retarded or unretarded mode. Four different dc voltage/polarity combinations are used to provide an in-flight option of functioning delays. Inadvertent application of RF signals from the Fuze Function Control Set to these fuzes can cause erratic arming delays. The MK 344 fuze, because of tactical restrictions, is limited to delivery in the unretarded mode only. Delivery tactics are therefore similar to the M990E1 or M990E4.

(U) ELECTRIC FUZE OPERATION

(U) Regardless of the method used to select the delay, at completion of the required arming time the dc voltage causes rotation of a mechanical rotor in the fuze. This rotor aligns the detonator with the booster and closes the firing circuits with the exception of the final inertia-operated impact switch. At this point the fuze is *armed* and is, in all respects, ready to fire.

(U) On impact, the impact switch closes and the stored dc voltage detonates the fuze after the selected functioning delay has elapsed.

(U) Mechanical safety is provided in electric fuzes by a gag rod which physically prevents rotation of the rotor. This gag rod is held in place by an arming wire which is withdrawn from the fuze at weapon release. For electric fuzes, the arming wire is positively connected to the bomb rack rather than to one of the bomb arming solenoids. As a result, the gag rod is always withdrawn when the weapon leaves the rack regardless of the position of the nose tail arm switch in the cockpit. Thus, to assure *safe* -jettison, the Fuze Function Control Set must be in the SAFE position to prevent any electrical energy from entering the fuze.

(U) The impact switch in electric fuzes is sensitive to shock in any direction, and not merely along the longitudinal axis of the bomb. Therefore, the probability of an early burst due to bomb-to-bomb collision after fuze arming is greater than with mechanical fuzes which rely only on a longitudinal force.

(U) VT Elements

(U) VT elements may be used in conjunction with electric fuzes to provide an airburst capability. With these devices, the electric fuze operates in a normal manner except that an independent source of electrical energy from the VT element bypasses the impact switch in the fuze and detonates the weapon above the target. In this mode, the electric fuze will detonate on impact if the VT element has not operated. When VT elements are being used it is suggested that the functioning delay be selected for instantaneous so as to provide the most effective backup in the event of VT element failure.

(U) Delivery Options

(U) Fuzes in the M990 series and the MK 344 are not authorized for retarded delivery. When these fuzes are used in SNAKEYE bombs and an option of retarded or unretarded delivery is required, a mechanical fuze must be installed in the nose for use in the retard mode. MK 376 electric fuzes permit an option of retarded or unretarded delivery. See Retarded or Unretarded Delivery Option.

(U) For more detailed technical information on electric fuzes refer to NAVAIR 11-5A-17.

(U) ARMING WIRES

(U) Loss of an arming wire from a mechanical fuze will allow the fuze to arm while the weapon is still on the bomb rack. When the weapon is released, it can detonate dangerously close to the aircraft if subjected to bomb-to-bomb or bomb-to-aircraft collision.

(U) Electric fuzes use the arming wire as a mechanical backup safety device to guard against stray voltage and will not arm upon withdrawal of the arming wire unless also charged by a voltage from the delivery aircraft at weapon release. VT elements (MK 43 and M20) use arming wires as an alternate means of initiation and not as a safing device.

(U) A proper preflight check can minimize the possibility of arming wire failure. Most mechanical fuze and VT element arming wire installations are simple to check. Electric fuzes in the tail well are more difficult to observe.

(U) One of the most common causes of arming wire loss from mechanical fuzes is faulty installation of the Fahnestock or safety clips which hold the arming wire in the fuze. When properly installed, these clips will hold the arming wire securely at all carriage speeds up to the maximum authorized. The clips are slipped over the free end of the arming wire and are snugged up against the arming vane. If they are missing or loose, the airstream may blow the arming wire free of the arming vane and permit the fuze to arm. If the clips are not snug against the arming vane, it is possible for them to whiplash in the airstream. This can result in a sheared arming wire.

(U) Assure that there is no excess slack in the arming wire. An excessively long arming wire can be dangerous. It should closely follow the contour of the bomb body but should exert no strain on the bomb arming solenoid. The arming wire should extend through the arming vane 3 to 4 inches. Check that all warning tags and safety pins have been removed from the fuze and that desired delays or options have been selected. For specific data on arming wire installations, refer to the Conventional Weapons Loading Manual.

(U) CARRIAGE AND RELEASE SPEED RESTRICTIONS

(U) Individual fuze summaries contained in this section list the maximum carriage and release speeds. These are fuze imposed restrictions only. There may be further restrictions due to bomb rack or weapon limitations. In no case should these limitations be exceeded.

(U) Carriage speed limitations are usually imposed by the arming wires but in certain cases are the result of vibrations which occur in the bomb structure. Release speeds limitations are imposed by the aerodynamic characteristics of the fuze. In certain fuzes, higher-than-authorized release speeds will destroy the arming vane or cause erratic or faulty arming. In general, maximum carriage and release speeds are determined by safety considerations but, in certain cases, reliability is the governing factor.

(U) Release-speed limits are normally higher than the carriage-speed restrictions. These higher speeds are authorized on the assumption that they will be experienced for only brief periods during each mission. The cumulative time spent at the maximum release speed should not exceed 15 minutes.

(U) If maximum carriage speeds are exceeded, the fuzes may be armed or completely unreliable and should be dropped as soon as practicable. They should not be returned to a field or carrier.

(U) Note that certain fuzes require a *lower* release speed than carriage speed (MK 346 and MK 347). In these cases, excessive release speeds can reduce fuze reliability, can cause a bypassing of the desired functioning delay time, or can result in excessive penetration of the weapon. Excessive penetration is undesirable because it minimizes the blast and cratering effect of the weapon. It becomes a major problem with low-drag weapons fuzed for functioning delays of 50 milliseconds or more when released from high altitudes or at high speeds against soft targets. Excessive release speeds can also cause weapon breakup or deflagration of bombs fuzed for the longer functioning delays.

(U) Early Bursts

(U) It is possible for a fuze to detonate immediately upon arming or at some time after arming but prior to that intended. This is known as an early burst and can result from fuze malfunction, bomb-to-bomb or bomb-to-aircraft collision, or from mutual interference between bombs with VT elements installed.

(U) Early burst probability is highest in electric fuzes. The expected rate is about one in 1000 for M990 series fuzes and 1 in 4500 for MK 344/376 fuzes. When a VT element is used for initiation, the early burst rate for both types increases significantly and may occur in about three out of every one-hundred releases. NEW NEW

(U) Early bursts can also occur with mechanical fuzes. Accurate test data are not available, but the probability of early burst with mechanical nose fuzes is estimated to be about one in one hundred thousand. This can result from bomb-to-bomb collision and can also be caused by mechanical malfunction. Most mechanical fuzes require longitudinal impact and are therefore less susceptible than electric fuzes to detonation from bomb-to-bomb collision. Careful observation of installation procedures will keep the possibility of mechanical malfunction to a minimum.

(U) The hazards of an early burst will be minimized if the prescribed arming delay times listed in figure 2-10 are observed (Minimum Authorized Arming Times and Speeds).

(U) FUZE SAFETY AND RELIABILITY CONSIDERATIONS

(U) Fuzes have two basic functions. The first is to maintain the weapon in the safest possible condition until the instant that detonation is desired. The second is to assure reliable and timely detonation of the weapon. Achieving these two goals requires a carefully balanced compromise and it is important that delivery pilots understand the implications of this relationship. Two distinct factors must be considered to assure maximum safety in weapon delivery. They are *safe-escape distance and safe-separation time.*

(U) Safe-Escape Distance

(U) Safe-escape distance is the minimum acceptable distance, measured in feet, between the aircraft and the bomb at the time of intended detonation. Except for bombs fuzed to airburst, intended detonation is usually considered to occur at impact. As a general prudential rule, the *functioning* delay settings provided by the fuze should not be relied upon in computing safe-escape distances. Under conditions such as high-velocity impact on hard targets, a bomb can detonate immediately on impact regardless of the functioning delay set in the fuze. Safe-escape distance is an important factor in determining minimum release altitude.

(U) Safe-Separation Time

(U) Safe-separation time is the minimum acceptable separation measured in seconds, between the aircraft and the weapon at the instant the fuze arms. This separation is necessary to protect the delivery aircraft from fragmentation damage in the event of an early burst. The minimum safe-separation time is dependent upon such obvious factors as delivery maneuver, release speed, size of the bomb and size of the aircraft. A factor not so obvious is release altitude. Due to reduced air density, an early burst at high altitude will produce a larger fragmentation envelope than at lower altitudes.

(U) Minimum Authorized Arming Time

NEW

(U) An important factor in determining the safe separation time of both unretarded and retarded bombs and the Laser Guided Bomb is the specific fuze being employed. For example if the early burst rate is high it is mandatory that the safe-separation time be meticulously observed. Conversely, if a fuze has no tendency to early burst there is no requirement to observe any safe-separation limits in the delivery tactics. Unfortunately, there are no fuzes which will assure a zero probability of early burst.

NEW

(U) As a consequence, minimum authorized arming times with various weapons and delivery maneuvers have been established. They are based upon a combination of safe-separation limits and early burst probabilities. The product of these two factors will determine whether the risk of fragmentation damage to the aircraft is within acceptable limits. Figure 2-10 sheet 1, indicates the minimum authorized arming times when using M904 series mechanical fuzes and MK 344/376 or M990 series electric fuzes in both VT and non-VT modes. These times are applicable for unretarded and retarded weapons as well as the Laser Guided Bomb configurations. (Minimum authorized arming time for the LGB is the same as that for the MK 82 and 84 unretarded bombs delivered under the same release condition.) Any deviations to any of these times must be approved by the OTC (Officer-in Tactical-Command). Figure 2-10 sheet 2, includes the probabilities of fragment damage in the event of an early burst under various delivery conditions and also contains the method for computing overall risk probabilities. This data is included to enable the OTC to assess the increased risk which will result if it becomes necessary to deviate from the prescribed arming times given in figure 2-10 sheet 1.

NEW NEW

WARNING

The minimum authorized arming times and speeds must be observed and followed for each type of delivery as depicted in figure 2-10. It is paramount that the crews of all aircraft be aware of the probabilities of fragment hit in the event of early burst when the arming time is less than the minimum authorized arming time prescribed for the delivery maneuver. This could conceivably occur when a dive delivery mission is diverted to a level delivery mission. Refer to Safe Escape Considerations, part 3.

NEW NEW NEW NEW

(U) Minimum Release Altitude

(U) In addition to the limits imposed by bomb fragmentation and terrain clearance, minimum release altitudes are also imposed by the fuze. Very simply, the fuze must be released at a sufficient distance above ground level to permit arming. This is a straightforward computation; however, pilots must take into consideration the tolerances or variations in arming times for each specific fuze. As an example, arming delay times for M990E series fuzes can vary from -10 percent to +20 percent of the nominal arming time. Thus, a nominal 5.5 seconds arming delay could range anywhere from 4.9 to 6.6 seconds and to assure detonation, at least 6.6 seconds time of fall must be allowed.

(U) Dual Fuzing

(U) Dual fuzing may be employed either as a means of providing an inflight option of arming and functioning delays, or as a means of increasing reliability. A large number of fuze combinations may be used; however, careful selection of nose and tail fuze combinations is required to ensure the optimum combination. Four typical combinations are shown in the table.

NEW NEW

NOSE Fuze/Arm. Delay (seconds)	TAIL Fuze/Arm. Delay (seconds)	REMARKS
A. M904 (any arming time)	MK 346 long-delay fuze	Combination provides flexibility for alternative strike if original mission requirements change.
B. M904/6 sec. (dive-unret.)	M990E3/10 sec. (level)	No option of retarded delivery and limited functioning delay option.
C. M904/10 sec. (level)	MK 344/5.5 sec. (dive-unret.)	MK 344 provides additional functioning delay options.
D. M904/10 sec. (level)	M990E1/E4/5.5 sec. (dive-unret.)	No option of retarded delivery and functioning delay option limited to the delay available in either the nose or tail fuze. Good penetration of hard targets in dive mode.

(U) The advantages of dual fuzing must be balanced against the added complications in weapon loading and pilot cockpit procedures and the potential hazards to the delivery aircraft in the event of procedural errors. For example, in a level delivery using combination D above, pilot error could result in advertent armed release of the M990 fuze. With the short (5.5 sec.) arming time of this fuze, a potential early burst hazard exists.

(U) Dive or Straight-and-level Delivery Option

(U) Most unretarded dive deliveries require 5.5-second arming delay whereas level unretarded deliveries require either an 8- or 10-second delay. Fuzing combinations which will provide this option are listed in table above.

(U) Dual fuzing requires that the pilot be fully briefed on the arming-wire rigging of the weapon and the proper armament-switch settings for selection of desired option. In the examples given above, it is mandatory that the fuze set for the dive option (5.5 or 6 sec) be released safe if a straight and level release is to be made. Failure to observe this precaution would create a high probability of fragment damage in the event of an early burst. For dive delivery releases, both fuzes may be released armed, however, the fuze with longer delay arming times will probably be a dud.

(U) Functioning Delay Option

(U) The MK 344 and MK 376 electrical tail fuzes provide an in-flight option of functioning delays. If neither of these fuzes is available, it will be necessary to employ dual fuzing if a functioning delay option is required. As an example, an M904 set for 6-second arming delay and instantaneous functioning delay may be used in combination with an M990E1 tail fuze with 5.5 second arming delay and with a 0.50-second functioning delay. This example would provide the option of dive bombing either a soft or hard target.

(U) Redundant Fuzing For Increased Reliability

(U) If mission requirements demand near 100% fuze reliability, a nose and tail fuze set for essentially the same arming and functioning delays may be used. Redundant fuzing is currently employed for all firebombs.

(U) Retarded Or Unretarded Delivery Option

(U) Minimum arming times and safe escape distances for retarded delivery are considerably lower than for unretarded delivery. For a fuze to be compatible with both types of delivery, it must permit selection of the proper arming time for each type of delivery and also contain a self-dudding capability in the event the weapon fails to retard. Without these safeguards, an early burst at the short arming times used with retarded delivery would probably cause damage to the delivery aircraft if the SNAKEYE fins did not open. Similarly, a SNAKEYE fin failure during a low level, high-speed release could result in the bomb impacting and detonating directly beneath the aircraft with disastrous results.

(U) M990 series electric fuzes do not contain these safeguards and are not authorized for retarded delivery. Although the MK 344 does provide these safeguards, it is authorized for unretarded delivery only. Refer to the MK 344 data sheet. Mechanical nose fuzes may be used in the retard mode but they must be interconnected with the SNAKEYE fin by an additional arming wire so that the fuze will remain safe in the event the fins fail to open. Should the fins open but then separate from the weapon, the bomb will usually tumble, thus increasing the arming time or dudding the nose fuze as well as increasing the separation distance from the aircraft.

(U) The MK 376 fuze is the only fuze which permits an in-flight option of retarded or unretarded delivery. The MK 376 provides safe delay for unretarded straight-and-level delivery as well as retarded delivery. The MK 376 fuze contains a special dudding circuit which ensures increased safety in the event of SNAKEYE fin failure.

(U) If MK 376 fuzes are not available and a pilot option of retarded and unretarded delivery is required, it is necessary to employ dual fuzing. For the longer arming delay required for unretarded releases, an M990 or MK 344 fuze is installed in the tail. A mechanical nose fuze, rigged as noted above, is used

for the short delay required for the retarded option. For retarded delivery, the Fuze Function Control Set must be set to SAFE so that the electric fuze will not be energized upon weapon release.

(U) SELECTION OF FUNCTIONING DELAY OPTIONS (MK344/376)

(U) Weapon effectiveness is directly related to the selection of an appropriate fuze functiong mode. Studies have demonstrated that a weapon, producing 100% damage to a target, given the optimum functioning mode, will produce as little as 1% damage given the worst possible functioning mode.

(U) Because the functioning delay mode of mechanical fuzes is not inflight selectable, the pilot has no functioning delay mode option available to him if he is diverted from his original to an alternate target. However, the MK 344 and 376 fuzes provide at least three (four, when a VT nose element is installed on the bomb) inflight selectable delays.

Note

Certain targets require bomb penetration to maximize weapon effects. For these cases, the bomb should be fitted with a steel nose plug and cavity liner to ensure bomb survival at impact. If the weapon is fitted with a VT nose element, targets which are suitable for either an airburst or instantaneous surface burst should be selected. The nose plug and liner provide the structural integrity to the bomb which is required for it to survive impact.

(C) The following guidelines serve as a rule-of-thumb in the selection of the best functioning mode so as to optimize the effectiveness of electric fuzes against targets of opportunity.

a. A maximum diameter crater can be produced with a 15-millisecond delay. This delay is most effective in cratering reenforced runways, roads, or packed soil, whether dry or muddy. The 100-millisecond delay provides excessive penetration in most soils which tends to minimize the diameter of the resulting crater. (On hard-packed soils such as are found on roads or under runways, the weapon will come to a complete stop shortly after penetration, so crater diameter will be the same irrespective of the delay actually used. Therefore, the use of 100 milliseconds doesn't accomplish anything not accomplished by a 15-millisecond delay.)

b. Maximum weapon penetration will occur about 50 milliseconds after weapon impact. If maximum penetration is desired, 100 milliseconds should be selected. Maximum penetration is required for destruction of underground bunkers and storage tanks, buildings of more than two stories, ships such as cruisers and heavy DD's, and dirt-covered hangars. Maximum damage is inflicted upon bridge abutments and tunnels by "earth shaking" resulting from deep penetration.

c. The 15-millisecond delay is most effective against bridge spans, heavily constructed single-story buildings, stonework defenses, and railroad yards. Above-ground storage tanks and armored vehicles are most effectively destroyed by either an instantaneous or by a 15-millisecond delay, with the delay being more effective in the event of a direct hit. The steel nose plug and cavity liner should be installed if the pilot opts for the delay mode.

d. Instantaneous functioning with electric fuzes is truly instantaneous as compared with the non-delay mode for mechanical fuzes. Fragmentation effects are maximized, particularly when used with MK 81 bombs. Cratering is virtually non-existant because there is no weapon penetration. Therefore, targets which are protected by even a light surface covering are not effectively damaged. On the other hand, aircraft parked in the open, radar vans, missile fire control equipment, unarmored vehicles, and personnel are good targets for an instantaneous surface burst. Above-ground storage tanks and armored vehicles can be damaged or destroyed by fragmentation from a near-miss surface burst.

e. A VT airburst is most effective against revetted aircraft, troops in foxholes and open trenches. The only means of getting a well revetted target, short of a direct hit, is with an airburst. The VT elements will function against heavy foliage but the foliage itself can act as a shield for many targets. Therefore, to maximize damage when the target is covered by thick forest canopy, the MK 43 VT element should be mechanically initiated and the Fuze Function Control Panel of the electric bomb fuzing system set to a 100-millisecond delay. (This capability is not present with the M20/M20A1 VT element.)

f. The preceding guidelines hold true within limits for all MK 80 series bombs, and while certain bombs are more effective against specific targets than others, they are all correct within the general range of effectiveness of the four available functioning modes.

g. Refinements of this data are available from the Joint Munitions Effectiveness Manual (JMEM).

(C) Summary Of Functioning Delay Options For Best Target Kill Probability (Typical)

Target	Preferred Functioning Delay	Alternate Delay (if applicable)
Tanks, armored vehicles (direct hit)*	Inst	VT
	0.015 sec	---
Jet aircraft on runway	Inst	VT
Jet aircraft behind revetment	VT	---
Personnel in open	Inst	VT
Heavy ships (DD and larger)	0.100 sec	0.015 sec
Light coastal ships, barges	0.015 sec	---
(near miss)**	0.100 sec	0.015 sec
Railroad rolling stock	Inst	VT
Railroad yards, tracks	0.015 sec	---
Buildings, single-story	0.015 sec	Inst
Multi-story	0.100 sec	---
Bridges, masonry	0.100 sec	---
Bridges, suspension	Inst	0.015 sec
Tunnels, bunkers, underground storage tanks storage tanks	0.100 sec	---
Runways	0.015 sec	---

*Probability of direct hit is substantially less than that for near miss. In general, therefore, Inst/VT functioning delay offers greater advantage.

**100-msec delay provides greatest hydrostatic shock damage to hull. In the event of direct hit, 100-msec bomb would completely penetrate vessel and would detonate beneath keel.

(U) GUIDELINES FOR DELIVERY MODE OPTIONS

(U) Delivery of weapons with an in-flight option of delivery modes will be safer and more effective if the following points are understood:

a. Operations with retarded weapons present a special hazard due to the possibility of SNAKEYE fin malfunction, or pilot error.

b. When SNAKEYE weapons are inadvertently released unretarded or the fins fail to open properly, the bomb is, for all intents and purposes, unretarded. Under these conditions, the bomb will follow closely beneath the aircraft for a considerable period of time. With the bomb fuzed for arming times normal to retarded delivery, an unacceptable safe separation hazard will exist and a very critical safe escape situation will occur at impact.

c. Using an M990 or MK 344 fuze in the retarded mode creates an unacceptable risk. The MK 376 is the only electric fuze which can safely initiate a weapon in the retard mode.

d. Short arming times (2 seconds) with mechanical fuzes, while potentially dangerous, are acceptable in the retarded mode due to lower probability of early burst. In addition, complete separation of a SNAKEYE fin from the bomb will usually cause the bomb to tumble and thus increase the arming time of a mechanical fuze.

e. Longer arming times (5.5 seconds or greater) and proper delivery maneuvers are required in most cases for safe unretarded dive delivery.

f. For straight-and-level unretarded releases, a minimum arming delay time of 8 seconds or more is necessary to provide safe separation.

(U) Fuze Selection

(U) The conditions outlined above combine to make the task of selection and use of fuzes quite complex. With any given fuze, safe-separation times will vary greatly with the size and type of bomb, altitude and speed of release, and delivery maneuver. For these reasons, not all fuze-bomb combinations are safe under all conditions. The characteristics of each fuze and its companion bomb must be carefully studied and fully understood.

MINIMUM AUTHORIZED ARMING TIMES AND SPEEDS

THE ARMING TIMES LISTED BELOW ARE THE MINIMUM AUTHORIZED FOR THE COMBINATION OF FUZES, BOMBS, RELEASE SPEEDS AND DELIVERY TACTICS INDICATED. THESE ARMING TIMES ARE BASED UPON THE FOLLOWING SAFETY CRITERIA:

1. THE PROBABILITY OF A FRAGMENT HIT ON THE DELIVERY AIRCRAFT IN THE EVENT OF AN EARLY BURST AT FUZE ARMING WILL NOT EXCEED 1 IN 10.
2. THE OVERALL PROBABILITY OF A FRAGMENT HIT PER EACH BOMB DROPPED WILL NOT EXCEED 1 IN 10,000

NOTES:
1. REFER TO M20 OR MK 43 SUMMARY SHEETS FOR MINIMUM RELEASE INTERVAL WHEN DELIVERY IS IN THE VT MODE.
2. ARMING TIMES ARE COMPUTED ON THE BASIS THAT THE AIRCRAFT WILL BE ESTABLISHED IN A 4-G PULL-UP WITHIN TWO SECONDS AFTER RELEASE OF DESIRED STIK LENGTH: PULL-UP TO BE HELD UNTIL NOSE IS AT LEAST 15° ABOVE HORIZON.
3. ARMING TIMES ARE COMPUTED ON THE BASIS THAT THE AIRCRAFT WILL BE ESTABLISHED IN A 40° BANK AND A 4-G (OR MAXIMUM G BEFORE THE ONSET OF BUFFET) PULL-UP WITHIN 2 SECONDS AFTER RELEASE OF THE LAST BOMB.

INSTRUCTIONS FOR USE OF CHART

A. DETERMINE MINIMUM AUTHORIZED ARMING TIME FOR THE TYPE OF DELIVERY, RELEASE SPEED AND WEAPON TO BE USED.
B. THE ARMING TIMES AVAILABLE WITH CURRENT FUZES ARE LISTED BELOW FOR READY CROSS REFERENCE:

FUZE	ARMING DELAYS
MK 344	5.5 – UNRET.
MK 376	2.6 – RET., 10.0 – UNRET.
M904 E2/E3/E4	2, 4, 6, 8, 10, 12, 14, 16, 18
M990 E1	5.5
M990 E3	10.0
M990 E4	5.5

C. IN ALL CASES, REFER TO APPROPRIATE BOMB TABLES TO BE SURE THAT THE PLANNED RELEASE ALTITUDE WILL PROVIDE SUFFICIENT TIME-OF-FALL TO PERMIT THE FUZE TO ARM.
D. OBSERVE MINIMUM RELEASE INTERVALS PRESCRIBED IN THE EXTERNAL STORES LIMITATION CHARTS TO MINIMIZE PROBABILITY OF BOMB-TO-BOMB COLLISIONS.
E. IN THOSE CASES MARKED "NA", NO SAFE ARMING DELAY TIME IS AVAILABLE.

TACTIC			MIN REL SPEED (KTAS)	M904 FUZES			MK 344/376 AND M990E (NON-VT)			VT MODE see note 1		
				81	82	83/117	81	* 82	83/117	81	82	83/117
DIVE-TOSS	ANY STIK LENGTH		400	4.0	4.0	6.0	5.5	5.5	5.5	5.5	5.5	5.5
DIVE UNRETARDED (10° OR OVER) WITH 4G PULL-UP see note 2	SINGLE RELEASE OR ZERO STIK SALVO (100 MS OR LESS)	10° TO 30° DIVE	400	6.0	6.0				5.5	5.5	5.5	10
		OVER 30° DIVE	400						5.5	5.5	5.5	
	MULTIPLE RELEASE (1 SECOND STIK)	10° TO 30° DIVE	400						5.5	10	10	
		OVER 30° DIVE	400			6.0	5.5	5.5	10			
	MULTIPLE RELEASE (2 SECOND STIK)	10° TO 30° DIVE	400		6.0	8.0	10	10				
		OVER 30° DIVE	400	6.0	8.0	8.0						
LEVEL UNRETARDED WITH STRAIGHT AHEAD RECOVERY see note 3	0 to 5000 ft. (MSL)		350	8.0		8.0						
			450	6.0		8.0						10
	6000 TO 10,000 FT (MSL)		350	8.0		10						NA
			450		8.0	8.0						10
	11,000 TO 15,000 FT (MSL)		350		10	10						NA
			450		8.0	10					10	NA
	16,000 TO 20,000 FT (MSL)		350		10	10					NA	NA
			450		10	10					10	NA
LEVEL UNRETARDED WITH WINGOVER RECOVERY see note 3	MULTIPLE RELEASE (1 SECOND STIK) 0 TO 15,000 FT (MSL)		350	8.0	8.0	8.0						10
			450	6.0	6.0	8.0						10
	MULTIPLE RELEASE (1 SECOND STIK) 16,000 TO 20,000 FT (MSL)		350	8.0	8.0	10						10
			450	8.0	8.0	8.0	10	10	10	10	10	10
RETARDED DIVE OR LEVEL WITH 4G PULL-UP see note 2	MULTIPLE RELEASE MK 81/82 (1 SECOND STIK)	M990 SERIES AND MK 344 FUZES NOT AUTHORIZED IN RETARDED MODE. 2 SECOND ARMING DELAY MAY BE SAFELY USED WITH M904 SERIES FUZES ONLY IF FUZE AND SNAKEYE FIN ARE INTERCONNECTED WITH AN ARMING WIRE AND RELEASE SPEED IS AT LEAST 450 KTAS. MK 376 FUZE AUTOMATICALLY SELECTS 2.6 SECOND ARMING DELAY UPON SENSING RETARDATION PROVIDED RELEASE SPEED IS 400 KCAS OR GREATER.									
CONFIRMATION LABS	MULTIPLE RELEASE	USE THE SAME ARMING DELAY TIMES LISTED UNDER DIVE UNRETARDED FOR THE STIK LENGTH, RELEASE SPEED AND WEAPON TO BE DELIVERED.										

* Also applicable to Laser Guided Bomb.

UNCLASSIFIED

FDB-1T-(106-1)

Figure 2-10 (U) (Sheet 1 of 2)

MINIMUM AUTHORIZED ARMING TIMES AND SPEEDS - CONTINUED

COMPUTATION OF PROBABILITIES OF FRAGMENT HITS FROM EARLY BURSTS

The OTC may approve deviations to the Minimum Authorized Arming Times prescribed in sheet 1 when the tactical advantage to be realized by use of shorter arming times will justify the added risk which will result. Deviations should be approved only when the prescribed arming times will substantially limit or degrade mission effectiveness. It is recommended that deviations be approved only when using M904 series mechanical nose fuzes. The very low probability of early burst of this series fuze may permit use of lower arming times under certain tactical situations without increasing the overall risk above that warranted by the mission involved. In any case, it must be recognized that an early burst at low arming times will not only increase the probability of a fragment hit but will also increase the severity of damage in the event of a hit.

WARNING

The Minimum Authorized Arming Times prescribed in sheet 1 are computed on the basis that the probability of a fragment hit on the delivery aircraft in the event of an early burst ($P_{H/EB}$) must not exceed 1 in 10 (.10) and, in addition, the overall probability of a fragment hit per each bomb dropped (P_H) must not exceed 1 in 10,000 (.0001).

When deviations to this safety criteria are necessary, latitude may be exercised in accepting higher values of $P_{H/EB}$ but the established limit of P_H of 1 in 10,000 must not be exceeded.

The method of computing fragment hit probabilities is as follows:

1. To compute the probability of a fragment hit per each bomb dropped (P_H), it is necessary that the early burst probability of the fuze being used (P_{EB}) be multiplied by the probability of a fragment hit in the event of an early burst ($P_{H/EB}$). This relationship is shown in the following formula;

$$P_H = P_{EB} \times P_{H/EB}$$

2. The estimated probability of an early burst (P_{EB}) of current fuzes is as follows:

FUZE	PROBABILITY OF EARLY BURST (P_{EB})	
M904E2/3/4	1 in 100,000	(.00001)
MK 344/376	1 in 4,500	(.0045)
M990 E series	1 in 1,000	(.001)
MK 43/M20 VT elements	3 in 100	(.03)

NOTE

The above data are derived from range testing as updated by ordnance expenditures and incident reports.

3. The probability of the delivery aircraft receiving at least one fragment hit in the event of an early burst at arming ($P_{H/EB}$) for various arming times, bombs and delivery tactics is as follows:

TACTIC			MIN REL SPEED (KTAS)	PROBABILITY OF FRAGMENT HIT IN EVENT OF EARLY BURST ($P_{H/EB}$)											
				MK 81				* MK 82				MK 83/117			
				4	5.5	6	8	4	5.5	6	8	4	5.5	6	8
DIVE-TOSS	ANY STIK LENGTH		400	.03	.00	.00	.00	.09	.00	.00	.00	.26	.00	.00	.00
DIVE UNRETARDED (10° OR OVER) WITH 4G PULL-UP	SINGLE RELEASE OR ZERO STIK SALVO (100 MS OR LESS)	10° TO 30° DIVE	400	.22	.00	↑	↑	.51	.00	↑	↑	.85	.00	.00	↑
		OVER 30° DIVE	400	.41	.00			.74	.00			.97	.01	.00	
	MULTIPLE RELEASE (1 SECOND STIK)	10° TO 30° DIVE	400	.99	.01	↓		1.00	.02	↓		1.00	.10	.01	
		OVER 30° DIVE	400	1.00	.02	.00		↑	.08	.00		↑	.31	.04	
	MULTIPLE RELEASE (2 SECOND STIK)	10° TO 30° DIVE	400	↑	.13	.01			.35	.04			.67	.16	
		OVER 30° DIVE	400		.76	.10	.00		.89	.30	.00		1.00	.55	.00
LEVEL UNRETARDED WITH STRAIGHT AHEAD RECOVERY	0 TO 5000 FT. (MSL)		350		.55	.24	.01		.83	.54	.01		1.00	.84	.09
			450		.23	.09	.00		.61	.36	.01		.94	.73	.02
	6000 TO 10,000 FT. (MSL)		350		.87	.58	.02		.97	.80	.07		1.00	.99	.22
			450		.58	.24	.01		.86	.57	.02		↑	.89	.10
	11,000 TO 15,000 FT. (MSL)		350		.93	.76	.05		1.00	.90	.15			.99	.33
			450		.85	.53	.01		.96	.78	.05			1.00	.21
	16,000 TO 20,000 FT. (MSL)		350		.97	.82	.09		1.00	.95	.22			1.00	.44
			450		.92	.76	.04		.98	.91	.15		↓	1.00	.33
LEVEL UNRETARDED WITH WINGOVER RECOVERY	MULTIPLE RELEASE (1 SECOND STIK) 0 TO 15,000 FT (MSL)		350		.54	.20	.00		.81	.47	.00		1.00	.82	.01
			450		.14	.02	.00		.40	.09	.00		.79	.39	.00
	MULTIPLE RELEASE (1 SECOND STIK) 16,000 TO 20,000 FT (MSL)		350		.88	.60	.01		.99	.84	.03		1.00	.99	.14
			450	1.00	.45	.16	.00	1.00	.72	.39	.00	1.00	1.00	.76	.01

* Also applicable to Laser Guided Bomb.

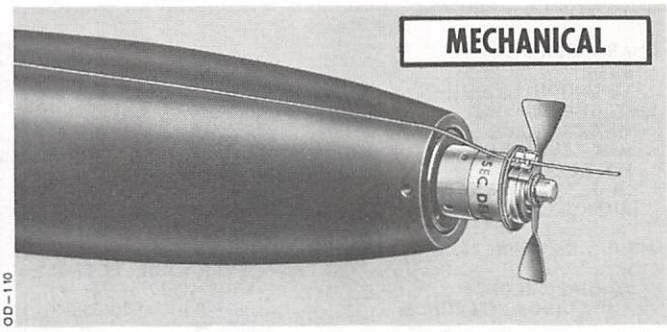
FDB-1T-(106-2)

UNCLASSIFIED

Figure 2-10 (U) (Sheet 2 of 2)

MK 347 NOSE FUZE

CHARACTERISTICS	
TYPE	MECHANICAL– IMPACT
LOCATION	NOSE
LIMIT SPEEDS	
MAX CARRIAGE	475 KCAS
MAX RELEASE	400 KCAS
MIN RELEASE	175 KCAS
IN–FLIGHT OPTIONS	NONE
AUTHORIZED BOMBS	Mk 81/ 82 LD and SNAKEYE (Not cleared for thermally protected bombs.)
ARMING AND FUNCTIONING DELAYS	
ARMING	0.7 to 1.2 seconds (a function of airspeed)
FUNCTIONING	12 seconds



DESCRIPTION

The sensitivity of the MK 347 will provide detonation on impact with shallow water or marsh. The sensitivity and the long functioning delay were designed for slow speed, low altitude retarded delivery. Release of this fuze at speeds in excess of 400 KCAS will result in unpredictable operation due to aerodynamic instability. Use only the FLAT vane that is shipped with these fuzes.

Although the probability of early burst is low, the short arming time of the MK 347 does not provide safe separation in the event an early burst does occur. This fuze should not be used if M904E3 fuzes with selectable arming times are available. The fuze must be interconnected with the Snakeye fin by an arming wire if delivery is to be in the retarded mode.

This fuze must not be used with the M1A1 Fuze Extension (Daisycutter) due to the long functioning delay.

Regardless of the delay settings used, any mechanical nose fuze may detonate instantaneously on impact with very hard targets (concrete runways, dams) and is therefore ineffective when penetration is necessary. Use tail fuzes for these conditions.

WARNING

This fuze does not provide safe separation in event of early burst. Use release conditions in which there is a low probability of bomb-to-bomb collision.

PREFLIGHT CHECKS

Check arming wire rigging, Fahnestock clips, removal of warning tags and fuze condition. A decal which reads 12 SEC DELAY is affixed to the fuze body.

WARNING

Fuze should be considered armed if the clearance between the two flanges on the head of the fuze is greater than 1/8 inch.

REFERENCES

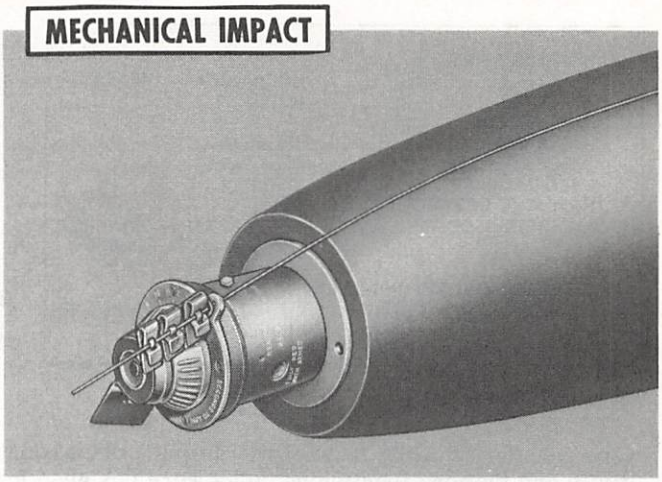
See References at the end of Fuzing and Fuze Limitations, part 1 of this section.

CONFIDENTIAL
FDB-1T-(107)

Figure 2-11 (C)

M904 E2/E3/E4 NOSE FUZE

CHARACTERISTICS	
TYPE	MECHANICAL – IMPACT
LOCATION	NOSE
LIMIT SPEEDS	
MAX CARRIAGE	475 KCAS
MAX RELEASE	525 KCAS
MIN RELEASE	175 KCAS
IN-FLIGHT OPTIONS	NONE
AUTHORIZED BOMBS:	M117 Mk 80 Series LD, SNAKEYE I
ARMING AND FUNCTIONING DELAYS	
	PREFLIGHT SELECTABLE
ARMING (SECONDS)	2/4/6/8/10/12/14/16/18
FUNCTIONING (SECONDS)	Instant. 0.01/0.025/0.05/ 0.10/0.25
ARMING TOLERANCE	±10 percent of arming delay setting.



DESCRIPTION

The M904 series fuzes permit preflight selection of several different arming and functioning delays. The arming delays are selected by a dial on the nose of the fuze. Functioning delays are selected by installation of the appropriate delay element in the fuze prior to installation in the bomb. The E3 embodies internal design changes which provide improved reliability against hard targets and increased sensitivity against soft targets (mud or water) in the retard mode. The E2 may dud if delivered against soft targets in the retard mode. The NEW E4 has a molded rubber compound collar over the fuze body to increase its resistance to cook-off in open fire. Other than this collar, it is identical to the M904E3.

Due to the potential hazards of short arming delays, a stop screw in the head of the fuze must be removed to select the 2 or 4 second setting. The stop screw must not be reinstalled with the fuze set at 2 or 4 seconds or the fuze may dud.

The 2 and 4 second settings are for use in the retarded mode. See Minimum Arming Times and Speeds. The fuze must be interconnected with the Snakeye fins by an arming wire if delivery is to be in the retard mode.

If this fuze is used with the M1A1 Fuze Extension (Daisycutter), a non-delay (INST) element must be installed in the fuze.

Regardless of the delay setting used, any mechanical nose fuze may detonate instantaneously on impact with very hard targets (concrete runways, dams) and is therefore ineffective when penetration is desired. Use tail NEW fuzes for these conditions. The M904E4 is the preferred fuze in this series due to its thermal protection.

PREFLIGHT CHECKS

Assure that proper fuze is installed and desired arming delay set. Check arming wire rigging, Fahnestock or safety clips and removal of warning tags. Check that stop screw is removed at 2 or 4 second settings.

WARNING

If the observation window of the M904 series fuze shows full red at any setting, the fuze is fully armed. The M904E2 window shows a white line at the 6- or 18-second setting if the fuze is safe. If no white line can be seen at the 6- or 18-second setting, or can be seen at any other time setting, the fuze is partially armed and should not be used.

The M904E3 and E4 fuze observation window shows green if safe. In addition, if the fuze is set at either 6 or 18 seconds, a white numeral 6 or 18 appears in the window. If the numerals do not appear at the appropriate settings, or appear at any other time setting, the fuze is partially armed.

Do not use a partially armed fuze. Arming delays will be shorter than the time indicated on the setting dial.

NEW Do not use an M904E2 or E3 with the fire retardant M148E1 Adapter Booster (identified by the nomenclature and fire resistant white paint on the exposed collar). This combination is more susceptible to high-order explosion in the event of fire than any other combination.

REFERENCES

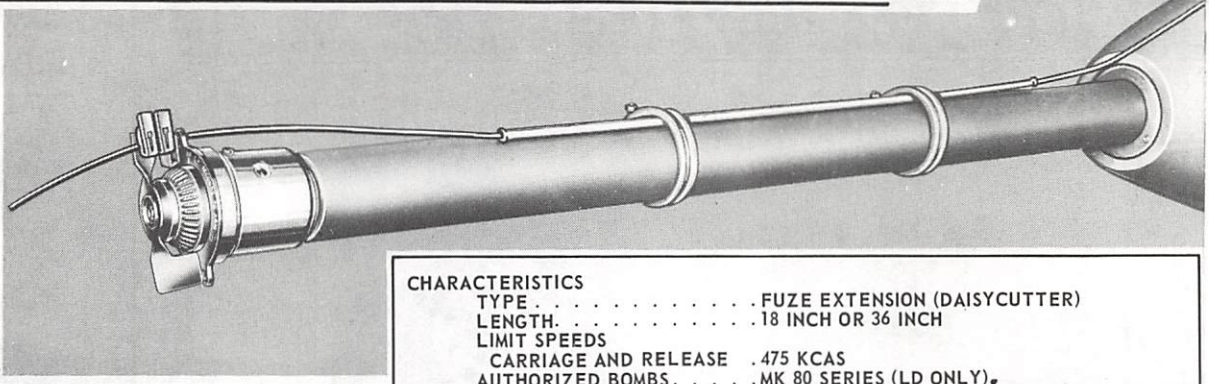
See Reference at the end of Fuzing and Fuze Limitation, part 1 of this section.

CONFIDENTIAL

FDB-1T-(108)

Figure 2-12 (C)

M1A1 FUZE EXTENSION (DAISY CUTTER)



OD-30

CHARACTERISTICS
TYPE . . . . . FUZE EXTENSION (DAISYCUTTER)
LENGTH. . . . . 18 INCH OR 36 INCH
LIMIT SPEEDS
CARRIAGE AND RELEASE . 475 KCAS
AUTHORIZED BOMBS. . . . . MK 80 SERIES (LD ONLY). NOT FOR USE WITH THERMALLY PROTECTED MK 80 SERIES BOMBS.
AUTHORIZED FUZES. M904E2/E3/E4

DESCRIPTION

The M1A1 Fuze Extension is a metal tube containing Composition B explosive filler. One end of the tube threads into the nose of the bomb and the other end receives a standard mechanical nose fuze. This device is designed to provide an above-ground burst capability for GP bombs.

Due to the sensitivity of the explosive filler (Composition B), fuze extensions are not authorized for carrier-based use nor for any arrested landings. It is also recommended that if an unsuccessful attempt to release has been made during the flight, the weapon should be jettisoned prior to landing.

For maximum effectiveness, the fuze must be set for *INSTANTANEOUS* functioning delay and the weapon should impact at a relatively low speed and at the steepest possible angle. Shallow, high speed impacts not only nullify the desired effect but also may increase the probability of shearing the extension from the bomb and causing a dud.

The use of the fuze extension may, under certain conditions, increase the probability of bomb-to-aircraft and bomb-to-bomb collisions with resultant early bursts. As a result, additional restrictions on release intervals and bomb rack loading may be imposed. See External Stores Limitations Chart.

Until further data becomes available, use the Sight Angles, Minimum Authorized Arming Times and Speeds, and Safe-escape data for the basic fuze combination being used.

WARNING

The M1A1 Fuze Extension is not authorized for carrier-based use and is restricted from any arrested landings.

If an unsuccessful attempt to release has been made during the flight, weapons equipped with the Fuze Extension should be jettisoned prior to landing.

See External Stores Limitation Chart for minimum release intervals and restrictions on bomb rack loading.

PREFLIGHT CHECKS
Make the normal checks prescribed for the fuze which is installed. Ensure that the fuze is set for *INSTANTANEOUS* functioning delay.

A single length of arming wire must be used. Arming wire extensions may break upon release and cause duds.

REFERENCES
See References at the end of Fuzing and Fuze Limitations, part 1 of this section.

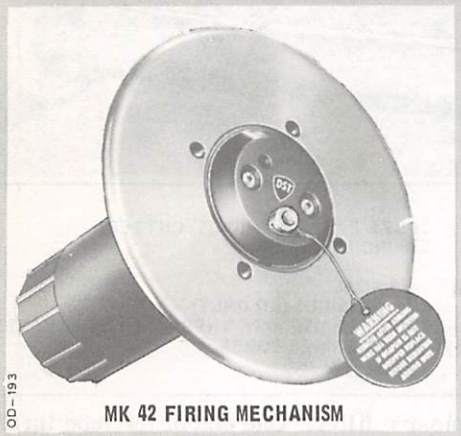
CONFIDENTIAL

FDB-1T-(109)

Figure 2-13 (C)

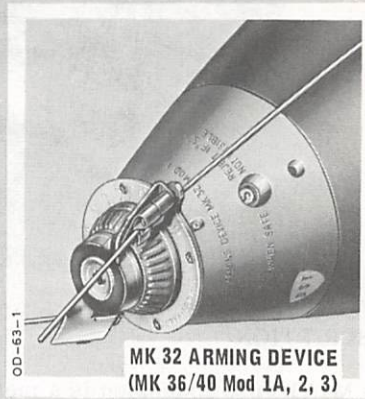
MK 36/40 DESTRUCTOR (DST) MOD 1, 1A, 2, 3 ARMING AND FIRING SYSTEM

MAGNETIC INFLUENCE



MK 42 FIRING MECHANISM

MK 30 ARMING DEVICE (MK 36/40 Mod 1)



MK 32 ARMING DEVICE (MK 36/40 Mod 1A, 2, 3)

CHARACTERISTICS

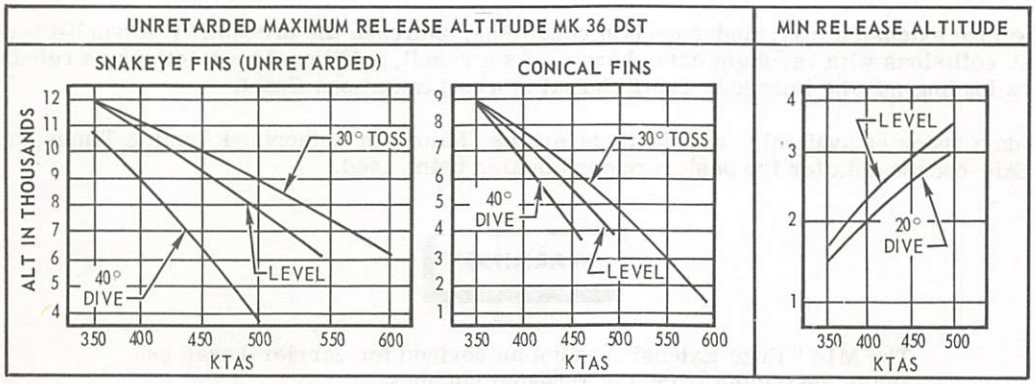
TYPE ..... MAGNETIC INFLUENCE
LOCATION ..... NOSE AND TAIL WELLS
COLOR/MARKINGS ..... NOSE DEVICE – MOD 1 (MK 30) – GREEN
MOD 1A, 2, 3 (MK 32) – GOLD
TAIL MECHANISM – BLACK WITH GOLD FLANGE

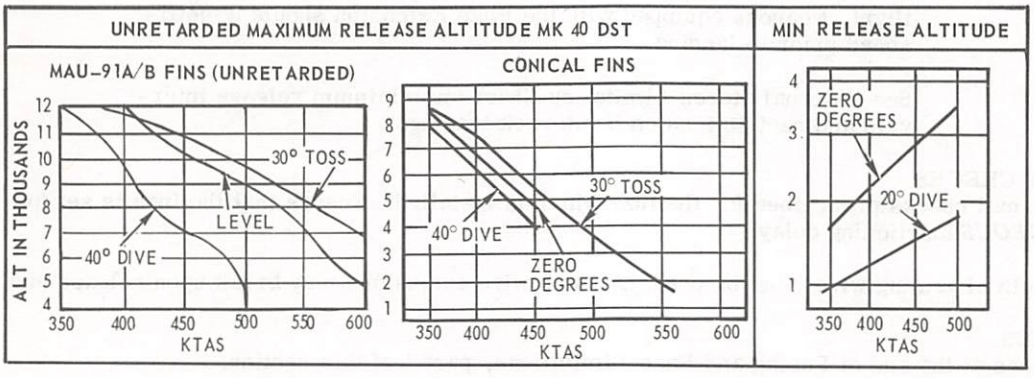
SPEED RESTRICTIONS (ALL MODS)

MAX CARRIAGE ..... 475 KCAS
MAX DELIVERY ..... 525 KCAS
MIN DELIVERY ..... 175 KCAS

DELIVERY OPTIONS:

MK 36 MOD 1 – Retarded only
MK 40 MOD 1 – Retarded only
MK 36 MOD 1A, 2, 3 – Free-fall or retarded
MK 40 MOD 1A, 2, 3 – Free-fall or retarded





CONFIDENTIAL

FDB-1T-(110-1)

Figure 2-14 (C) (Sheet 1 of 3)

MK 36/40 DESTRUCTOR (DST) MOD 1,1A,2,3 ARMING & FIRING SYSTEM-CONTINUED

FREE-FALL DELIVERY RESTRICTIONS. The MK 36 and 40 must not be delivered against water targets in the free-fall mode. For delivery against land targets the following restrictions are imposed to ensure that impact occurs at less than 900 fps and at an angle of 30° or greater. These limits are imposed to prevent ricochet and component damage and also prevent excessive weapon penetration.

RETARDED DELIVERY RESTRICTIONS. The MK 36 and MK 40 may be delivered against land or water targets in the retarded mode. No maximum altitude limits are imposed by the arming and firing system when delivery is in the retarded mode. However, to minimize probability of ricochet it is recommended that releases against land targets be made at 500 feet or greater; against water targets at 250 feet or greater.

ARMING DELAYS (PREFLIGHT SELECTED)

MK 36/40 Mod 1 (MK 30 Arming Device) Arming delay is limited to 2 sec (2 to 18 sec available).

MK 36/40 Mods 1A, 2, 3 (MK 32 Arming Device) 2.16 seconds (plus impact)

MK 42 Firing Mechanism: Delays are of higher classification. See NAVORD OP 3529.

NEW DESCRIPTION (MK 36/40 DST MODS 1A, 2, 3)

The MK 36 and MK 40 DST Arming and Firing System (Modification Kit MK 75) converts a MK 82 or MK 83 bomb to a Destructor which provides a magnetic influence firing capability. The weapon may be planted on land or shallow water and detonates when the magnetic field around the weapon is disturbed.

The arming and firing system consists of a mechanical arming device installed in the nose well and an electrical firing mechanism installed in the tail well. Although there are three Mods (1A, 2, 3) of the DST system available (see OP 3529) the only item of major tactical concern to the delivery pilot is the MK 32 nose arming device. This is a modification of the M904 mechanical nose fuze. The MK 32 arming device may be delivered either retarded or free-fall. Free-fall delivery is authorized only against land targets. The delivery characNEW teristics of all three Mods are identical; the Mod designation is controlled by the Mod designation of the MK 42 Mod 1, 2, or 3 Firing Mechanism.

The MK 32 arming device serves only an arm/safe function and is not intended to detonate on impact. When the MK 32 has been air-and-impact armed, an electric firing signal from the MK 42 Firing Mechanism in the tail is required to detonate the weapon. If MK 32 has not be armed, an electric firing signal from the MK 42 will initiate an explosive train in the nose device but will not fire the main booster charge and the weapon will dud.

The MK 42 is armed after a specific delay which must be preselected during weapon assembly. These delays are of a higher classification and are contained in OP 3529. Once armed, the MK 42 is triggered by the movement of any target which causes a change in the magnetic field of the weapon. Power for the firing signal is provided by a battery in the MK 42 and no electrical connections to the aircraft are required.

Various arming wire configurations are used depending upon whether freefall only, retard only or retard/freefall inflight options are desired. The arming wire connections must be carefully noted by the pilot to ensure proper switch settings for the desired option.

NEW DESCRIPTION (MK 36/40 DST MOD 1)

NEW The MK 36/40 DST Mod 1 uses the MK 30 Nose Arming Device and the MK 42 Mod 1 Firing Mechanism. The MK 30 Nose Arming Device is functionally similar to the MK 32 with the exceptions noted under characteristics, Delivery Options, Arming Delays, and Preflight Checks.

CONFIDENTIAL

FDB-1T-(110-2)

Figure 2-14 (C) (Sheet 2 of 3)

MK 36/40 DESTRUCTOR (DST) MOD 1,1A,2,3 ARM AND FIRE SYSTEM-CONTINUED

PREFLIGHT CHECKS

Check that the MK 30 is set for 2 seconds and that stop-screw in the fuze body has been removed. Special watertight plugs must be installed in the setscrew hole in forward end of the bomb and in the electric fuzing cable well. Check arming vane, arming wire rigging, and removal of all warning tags. Two Fahnestock clips are used on the MK 30 and MK 32.

WARNING

If MK 30 observation window shows full red or a white stripe the arming device is fully or partially armed and must not be used.

If MK 32 observation window shows a black 'A' on a red background it is armed and must not be used. In the safe condition, the MK 32 will show a white 'S' on a green background.

If the arming wire is withdrawn from the MK 42 Firing Mechanism, the MK 42 will commence operation at the end of the preset functioning delay. This will result in a dud, providing that the MK 30 or MK 32 Arming Device has not armed. If the MK 30 or MK 32 has been allowed to arm, a full scale detonation of the destructor will occur. Notify EOD immediately of any improper handling or rigging of the weapon.

REFERENCES

NAVORD OP 3529

See References at the end of Fuzing and Fuze Limitations, part 1 of this section.

CONFIDENTIAL

FDB-1T-(110-3)

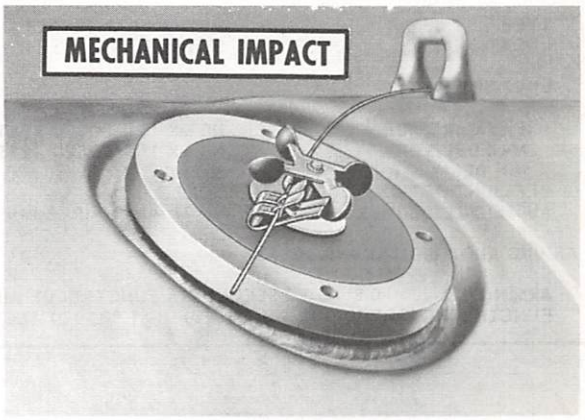
Figure 2-14 (C) (Sheet 3 of 3)

M918 MULTI-POSITION FUZE

CHARACTERISTICS
- TYPE ..... MECHANICAL IMPACT
- LOCATION ..... SIDE
- LIMIT SPEEDS
  - MAX CARRIAGE ..... 475 KCAS
  - MAX DELIVERY ..... 525 KCAS
  - MIN DELIVERY ..... NONE
- IN-FLIGHT OPTIONS ..... NONE
- AUTHORIZED BOMBS ..... MK 77-4 FIREBOMBS

ARMING AND FUNCTIONING DELAYS:
ARMING-(A FUNCTION OF AIRSPEED) TYPICAL TIMES:
- 0.8 SECOND AT 350 KCAS
- 0.6 SECOND AT 500 KCAS

FUNCTIONING - 0.3 SECONDS



DESCRIPTION

The AN-M173A1 and M918 fuzes were designed for use in fire bombs and are similar except that the M918 has been altered to provide a 0.3 second functioning delay. ONLY THE M918 MULTI-POSITION FUZE IS PRESENTLY AUTHORIZED.

To increase reliability, two fuzes are normally installed in all firebombs and both fuzes must be of the same type. The 0.3 second delay provided by the M918 will produce a larger ground pattern with longer burn time than that resulting from instantaneous fuzing. The fireball at impact may, however, appear smaller to the pilot.

The M918 fuze, with MK 273 Mod 0 igniter, is compatible only with the two side wells of the MK 77-4.

WARNING

Safe jettison of firebombs with this fuze installed cannot be assured. Impact may rupture the igniter, regardless of ARM/SAFE condition of the fuze, and ignite the fuel mixture.

PREFLIGHT CHECKS

Ensure that the proper fuze and igniter combination is installed. Check arming wire rigging, Fahnestock clips, removal of fuze warning tags and fuze condition.

WARNING

These fuzes should be considered armed if the clearance between the hub of the arming vane and the hexagonal shoulder of the fuze body is greater than 3/16 inch.

REFERENCES

See References at the end of Fuzing and Fuze Limitations, part 1 of this section.

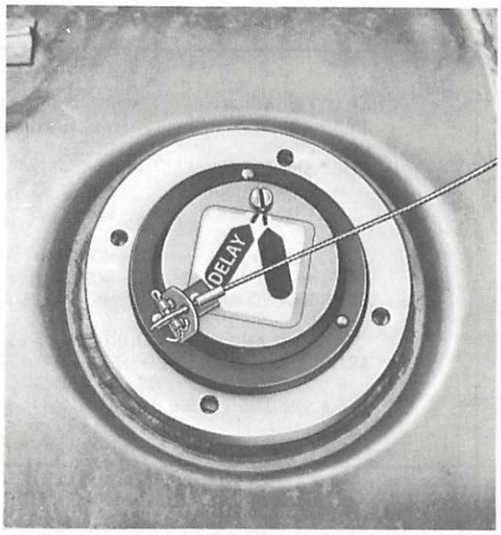
CONFIDENTIAL
FDB-1T-(111)

Figure 2-15 (C)

MK 13 MOD 0 FIRE BOMB INITIATOR

CHARACTERISTICS

TYPE	MECHANICAL IMPACT
LOCATION	SIDE WELLS
LIMIT SPEEDS	
MAX CARRIAGE	NO MK 13 IMPOSED RESTRICTIONS
MAX DELIVERY	NO MK 13 IMPOSED RESTRICTIONS
MIN DELIVERY	300 KCAS
IN FLIGHT OPTIONS	NONE
AUTHORIZED BOMBS	MK 77 MOD 4 FIREBOMB (SIDE WELLS ONLY)
ARMING AND FUNCTIONING DELAYS	
ARMING	0.8 TO 1.2 SECONDS (A FUNCTION OF AIRSPEED)
FUNCTIONING (PREFLIGHT SELECTED)	INST OR 0.27 SEC DELAY



DESCRIPTION

The Mk 13 Mod 0 Initiator consists of a Mk 343 Mod 0 Fuze and a Mk 273 Mod 1 Igniter and is for use in firebombs. Two Initiators must be used in each firebomb and are installed in the filler holes located along the upper surface of the bomb.

The top of the fuze is covered by a tear-out section similar to the opening in a modern beer can. At release, a lanyard attached to the bomb rack solenoid rips open the tear-out section and permits a small arming vane to pop up into the airstream. Simultaneously, a 1 second arming delay timer is started.

Either an instantaneous or a 0.27 second functioning delay may be set in the fuze by a setting screw on the fuze face. The setting on both initiators must be the same. For optimum effectiveness, the INST setting should be used against water targets and the DELAY setting against land targets. The Mk 13 Initiator provides greater sensitivity and safety than the older type firebomb fuzes.

Safe jettison of the Mk 77 firebomb cannot be assured. The high impact forces may cause the Initiator to deflagrate, regardless of the Arm/Safe setting of the fuze, and ignite the fuel.

PREFLIGHT CHECKS

Ensure that the desired functioning delay is set in both fuzes. Check rigging of the lanyards. The lanyard must lead directly to the closest solenoid and must not be routed through the bomb lugs. On MER/TER racks the lanyard should pass under the sway braces. If any separation of the tear-out tab has occurred, no matter how slight, the timer may have started prematurely and the fuze will dud.

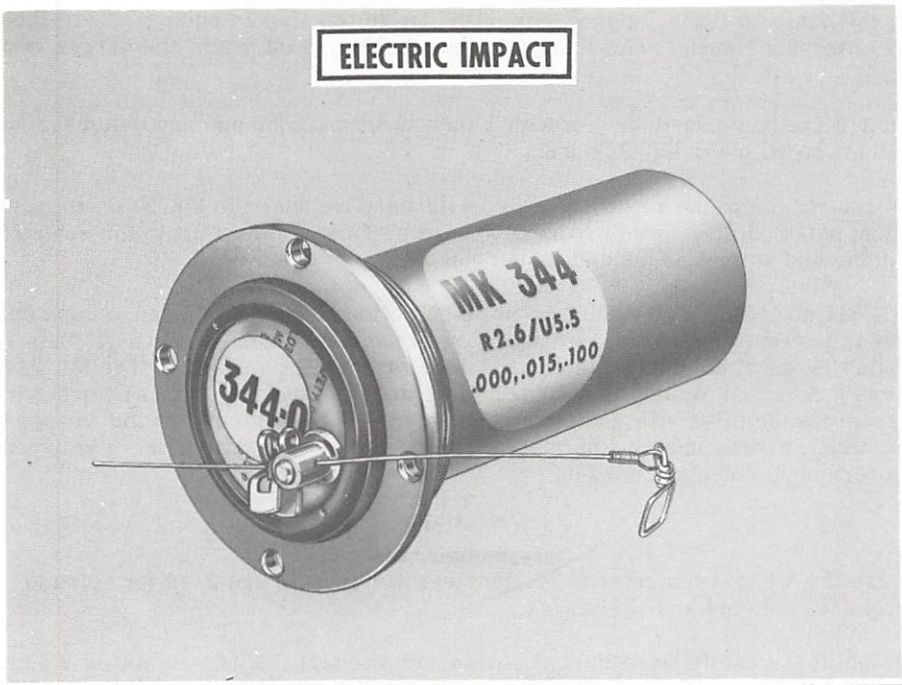
REFERENCES

See references at the end of Fuzing and Fuze Limitations, part 1 of this section.

FDB-1T-(112) CONFIDENTIAL

Figure 2-16 (C)

MK 344/376 TAIL FUZE



CHARACTERISTICS	
TYPE	ELECTRIC – IMPACT
LOCATION	TAIL
INFLIGHT OPTIONS	INDIRECT CONTROL OF ARMING DELAY (See Description) 3 FUNCTIONING DELAYS PLUS AIRBURST WHEN USED WITH VT ELEMENT
LIMIT SPEEDS	
MAX RELEASE	NO FUZE-IMPOSED LIMITATIONS
MIN RELEASE	400 KCAS (RETARDED MODE ONLY)
AUTHORIZED BOMBS	MK 80 SERIES, M117, SNAKEYE 1, MK 82 LASER GUIDED BOMB.
CONTROL SYSTEM	AWW–1, –4

NEW

ARMING DELAYS: ..... MK 344: 5.5 SEC UNRETARDED; RETARDED DELIVERY NOT AUTHORIZED.
MK 376: 10 SEC UNRETARDED; 2.6 SEC RETARDED.

FUNCTIONING DELAY: ..... VT; INST.; 0.015; 0.100

ARMING TIME TOLERANCES:	NOMINAL	0° TO 100°	–40° TO + 140°
MK 344:	5.5 SEC	5.0 TO 5.8	5.0 TO 6.1
MK 376:	2.6	2.3 TO 2.9	2.3 TO 3.0
	10.0	8.8 TO 10.7	8.8 TO 11.0

DESCRIPTION

The MK 344-376 fuzes are preferred replacements for the M990 series fuzes and provide improved safety and reliability. The MK 376 also provides a retarded delivery capability not available with the M990. The MK 344 is similar in design to the MK 376, the exception being the arming delay time.

NEW Both fuzes are initiated by DC voltages only and are controlled by the Electric Bomb Fuzing Systems AWW-1,-4. The pilot has the option of three functioning delays (instantaneous, 15 or 100 milliseconds, or VT airburst when used in conjunction with a VT element in the nose well. Arming delays are not directly selectable by the pilot but are automatically selected by means of an integral timer-decelerometer (MK 31 Safety Device) which shifts to the shorter (2.6-second) arming time when the fuze senses weapon retardation.

CONFIDENTIAL

FDB-1T-(113-1)

Figure 2-17 (C) (Sheet 1 of 2)

MK 344/376 TAIL FUZE-CONTINUED

A special dudding circuit in these fuzes prevents the potentially dangerous situation in which the weapon fails to retard in a SNAKEYE delivery, ricochets, and then detonates on subsequent delivery. In this case, the dudding circuit duds the bomb on initial impact, providing the initial impact occurs before the fuze has had a chance to arm in the unretarded mode. The weapon is thus dudded, minimizing the danger of a burst directly beneath the aircraft.

Both the MK 344 and 376 are authorized for use with Laser-Guided bombs and are delivered with the same delivery restrictions as for all other MK 82 bombs.

The minimum speed restriction in the retarded mode is imposed because the MK 31 decelerometer will not sense enough retarding shock at speeds lower than 400 KCAS. This could result in the selection of the longer, unretarded arming delay and automatic dudding of the weapon.

Although both the MK 344 and MK 376 provide automatic selection of the 2.6-second arming delay for retarded delivery, the MK 344 is currently authorized for delivery in the unretarded mode only. This restriction is due to the very narrow time range of the dudding circuit (2.6 seconds to 5.5 seconds). The MK 344 dudding circuit will be defeated unless a retarded weapon is delivered low enough to ensure impact before 5.5 seconds if fins malfunction. This presents the pilot with a narrow release envelope (400 feet). If the weapon is released above the maximum permissible altitude and the fins malfunction, the fuze will fully arm. The aircraft may well be inside of the frag pattern of the bomb at impact.

WARNING

Do not use the MK 344 for retarded deliveries. Refer to figure 2-10 for release parameters for MK 344 and -376 fuzes.

The MK 376 and MK 344 fuzes can be used in conjunction with the M20/M20A1 or MK 43 VT elements to provide a capability for VT initiation with any one of the two delay times in addition to VT-instantaneous operation. This delay mode may be useful for jungle canopy penetration. In the canopy penetration mode, the fuze is initiated by the VT's sensing the tree tops, but detonation is delayed until the bomb has penetrated through the foliage. (See the M20/M20A1 and MK 43 data sheets for further details.) See figure 2-10 for minimum authorized arming times and delivery restrictions.

WARNING

If arming wire is inadvertently withdrawn from these fuzes prior to weapon release, the MK 31 Safety Device will operate prematurely and cause the fuze to arm at 2.6 seconds after release in either the retard or freefall mode.

PREFLIGHT

Installed fuze is difficult to observe. Identifying decals are provided with each fuze to be affixed to the after bomb body as fuze is installed. Assure that electric fuzing cable is connected and arming wire is rigged as prescribed in Conventional Weapons Loading Manual.

REFERENCES

See Reference at the end of Fuzing and Fuze Limitations, part 1 of this section.

AWW-1/-4 OPTION SELECTOR SETTINGS
MK 344/376 Mode 0 FUZES

ARMING DELAY			FUNCTIONING DELAY	AWW-1 SELECTOR SETTING	AWW-4 SWITCH SETTING
Arming delay of MK 376 is automatically selected by the fuze depending upon whether the bomb is retarded or unretarded.			0.0 (INST)	F	INST
			0.015	H	DLY 1
	Retarded	Unretarded	0.1	G	DLY 2
MK 344	*	5.5			
MK 376	2.6	10.0			

* Not Authorized

CAUTION

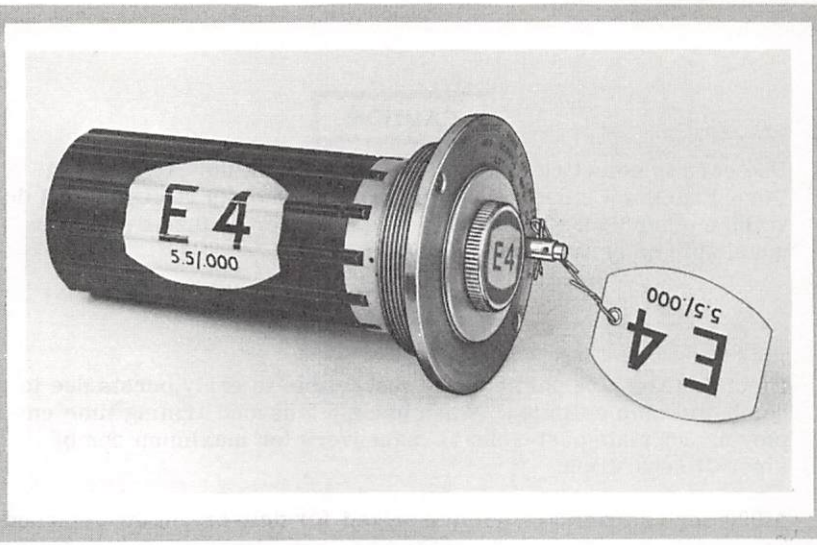
(AWW-1) Inadvertent application of an RF signal may cause unreliable or erratic arming delays.

FDB-1T-(113-2) CONFIDENTIAL

Figure 2-17 (C) (Sheet 2 of 2)

M990E-1/E-3/E-4 TAIL FUZES

ELECTRIC IMPACT



CHARACTERISTICS				
TYPE	ELECTRIC – IMPACT			
LOCATION	TAIL			
LIMIT SPEEDS	NO FUZE IMPOSED RESTRICTIONS			
IN FLIGHT OPTIONS	NONE			
AUTHORIZED BOMBS	MK 80 SERIES (LD ONLY), M117.			
CONTROL SYSTEM	AWW-1, -4			
ARMING AND FUNCTIONING DELAYS:				
		E-1	E-3	E-4
ARMING (Seconds)		5.5	10.0	5.5
FUNCTIONING (Second)		0.050	0.0	0.0
ARMING TOLERANCE	–10 TO +20 PERCENT			

DESCRIPTION

The M990E-1/E-3/E-4 are electric fuzes for use in unretarded MK 80 series and M117 bombs. These fuzes operate on dc voltage only and provide no in-flight options of arming or functioning delays. The 5.5 seconds arming time provided by the E-1 and E-4 is for use in dive delivery; the 10 seconds delay of the E-3 is for level delivery.

About 1 out of 1000 M990E series fuzes will detonate immediately upon arming. This increases to 3 out of 100 when used with VT sensing elements. This condition and the increased hazards of bomb-to-bomb collisions at high speed release demand extreme care in selection of arming times. Refer to the Minimum Authorized Arming Times and Speeds and the table for AWW-1,-4 Option Selector Settings.

CONFIDENTIAL

FDB-1T-(114-1)

Figure 2-18 (C) (Sheet 1 of 2)

M990 E-1/E-3/E-4 TAIL FUZES-CONTINUED

CAUTION

Use care in selecting fuze option settings with the AWW-1, -4 Fuze Function Control Set. The application of an rf signal or a dc voltage other than +300 volts to any M990 series fuze can cause unreliable or erratic arming delays.

WARNING

Electric fuzes are particularly susceptible to early bursts due to bomb-to-bomb collision. When using 5.5 second arming time employ appropriate post-release maneuvers for maximum bomb/aircraft separation.

M990 series fuzes are not authorized for delivery in the retarded mode.

PREFLIGHT CHECKS

Identifying decals are provided with each fuze to be affixed to the after bomb body as fuze is installed. Assure that electric fuzing cable between rack and the bomb is connected and arming wire is rigged as prescribed in Conventional Weapons Loading Manual.

REFERENCES

See References at the end of Fuzing and Fuze Limitations, Part 1 of this section.

AWW-1 OPTION SELECTOR SETTINGS
• SET SELECTOR TO POSITION E ONLY. • ARMING AND FUNCTIONING DELAYS ARE PRESELECTED. SEE SPECIFIC FUZE FOR AVAILABLE DELAYS **CAUTION** THE APPLICATION OF IMPROPER VOLTAGE OR OF AN RF SIGNAL TO DC-ONLY FUZES CAN CAUSE UNRELIABLE OR ERRATIC ARMING DELAYS.

NEW NEW

AWW-4 OPTION SELECTOR SETTINGS
1. Set selector to VT position only. This will NOT necessarily provide VT operation (see MK 43 TDD and M20/M20A1 coverage). 2. Arming and functioning delays are preselected. VT position provides +300 volts required for fuze initiation.

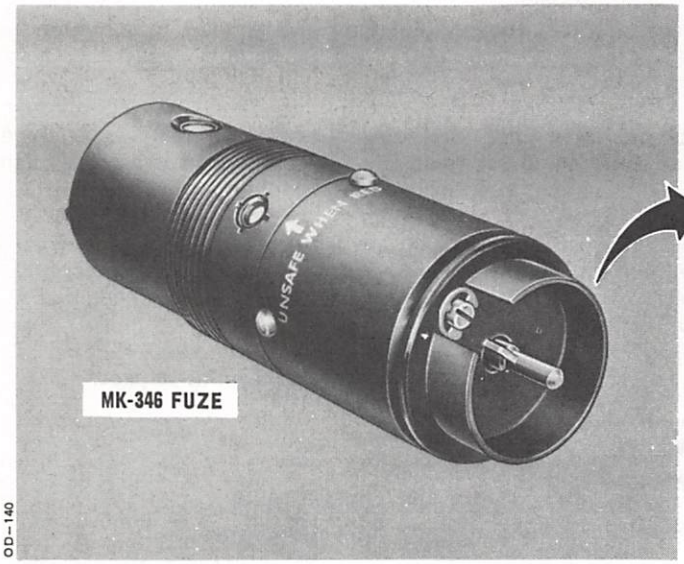
CONFIDENTIAL

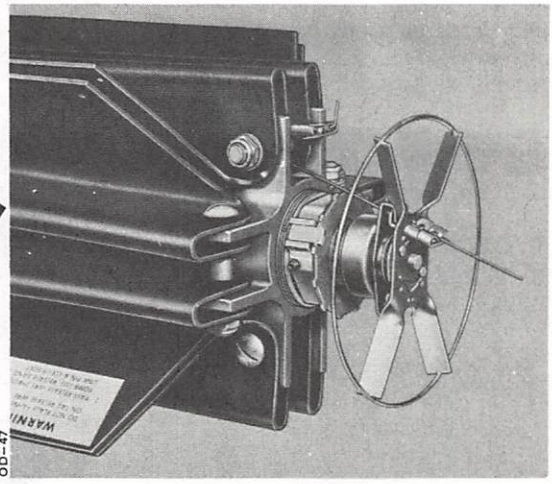
FDB-1T-(114-2)

Figure 2-18 (C) (Sheet 2 of 2)

MK 346 FUZE

MECHANICAL-LONG DELAY





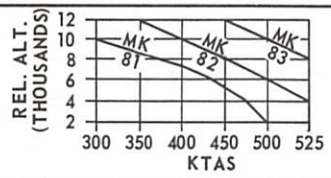
MK 4 TAIL DRIVE

CHARACTERISTICS

TYPE.....MECHANICAL LONG DELAY
LOCATION.....TAIL
CARRIAGE RESTRICTIONS: THESE RESTRICTIONS ARE IMPOSED DUE TO TAIL FIN VIBRATIONS WHICH CAN CAUSE DAMAGE TO THE ARMING ASSEMBLY.

SNAKEYE FINS	525 KCAS
CONICAL FINS	450 KCAS

DELIVERY RESTRICTIONS: THE FOLLOWING DELIVERY PARAMETERS WILL ENSURE 90% FUZE RELIABILITY. THESE RESTRICTIONS MAY BE EXCEEDED FOR TACTICAL REASONS BUT RELIABILITY WILL BE DEGRADED. SEE DESCRIPTION PARAGRAPH FOR FURTHER DETAILS AND FOR TARGET RESTRICTIONS.

UNRETARDED	RETARDED
MAX RELEASE SPEED/ALTITUDE	MAX REL SPEED – 525 KTAS MIN REL SPEED – 300 KTAS MIN REL ALTITUDE – 300 FT
	
MIN REL SPEED – NO MINIMUM MIN REL ALT – 1000 FT	

AUTHORIZED BOMBS.... MK 81, 82, 83 LD AND SNAKEYE (NOT CLEARED FOR MK 82 THERMALLY PROTECTED BOMBS)

ARMING AND FUNCTIONING DELAYS:

ARMING – WITH GOVERNED ARMING ASSEMBLY (MOD 1)

1.5 TO 2.0 SECONDS (UNRETARDED) PLUS IMPACT
1.5 TO 4.0 SECONDS (RETARDED) PLUS IMPACT

NOTE: AT HIGH SPEED RELEASE, RETARDATION CAUSES FUZE DRIVE TO LOSE SPEED THUS INCREASING THE ARMING TIME.

WITH DIRECT DRIVE ARMING ASSEMBLY (MOD 2). LESS THAN 1 SECOND PLUS IMPACT.

FUNCTIONING (PREFLIGHT SELECTED): 30 MINUTES TO 33 HOURS. (15 MINUTE INCREMENTS)

CONFIDENTIAL

FDB-1T-(115-1)

Figure 2-19 (C) (Sheet 1 of 2)

MK 346 FUZE-CONTINUED

DESCRIPTION

MK 346 is a clockwork fuze which provides a high degree of handling and delivery safety. The fuze employs two-stage arming; air travel plus impact are necessary to complete arming. The functioning delay does not commence until impact.

The arming and timer mechanisms of the MK 346 are sensitive to impact velocity and angle. Excessive impact velocity on hard targets may damage the timer and any impact on very soft targets may result in failure of the fuze to arm. Shallow angle impacts which result in ricochet may also fail to arm the fuze.

Due to this impact sensitivity, fuze operability will be very doubtful against any water target of depths over 20 feet or water with a soft, muddy bottom. High reliability can be expected against any type of land target, including mud or water of not more than 10 foot depth with a firm bottom, providing the release speed and altitude restrictions listed in the table are observed.

A steel nose plug must be installed in the bomb to prevent weapon break-up or deflagration at impact.

WARNING

Do not rely upon the long functioning delay time to provide safe escape. High speed impact on hard targets can detonate the weapon immediately on impact regardless of the functioning delay set in the fuze.

The fuze contains an anti-removal device which deters removal of the fuze from the bomb after it has armed. The delay setting dial cannot be observed once the fuze has been installed in the bomb.

A MK 3, 4 or 5 Arming Assembly is used to provide arming action to the fuze. These assemblies consist of an arming vane, drive mechanism and a drive shaft and may be used with either conical or SNAKEYE fins. The Mod 1 Arming Assembly is speed governed; the Mod 2 is direct drive. This accounts for the variation in arming times shown above.

PREFLIGHT CHECKS

Fuze will be difficult to observe. Check arming wire rigging, condition of arming vane and removal of warning tags. The Mod 2 Arming Assembly has DIRECT DRIVE stencilled on the hub of the fuze drive. A steel nose plug must be installed in the bomb.

WARNING

A red and black band in the observation window indicates that first stage arming has occurred. Timer may be running.

REFERENCES

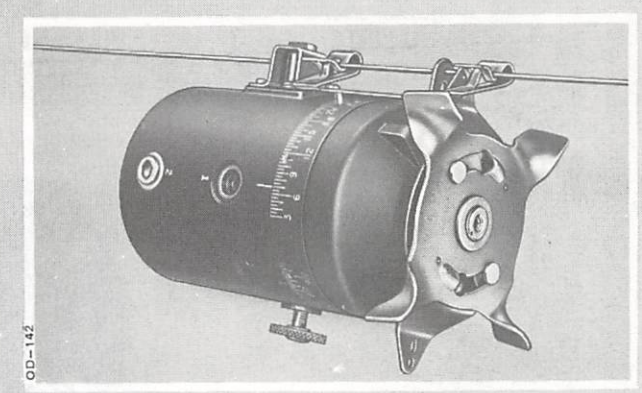
See Reference at the end of Fuzing and Fuze Limitations, part 1 of this section.

FDB-1T-(115-2)

Figure 2-19 (C) (Sheet 2 of 2)

M907 E1/E2 FUZE

MECHANICAL TIME (AIRBURST)



CHARACTERISTICS	
TYPE	MECHANICAL TIME (AIRBURST)
LOCATION	NOSE
LIMIT SPEEDS	
MAX CARRIAGE	600 KCAS CBU 24/29/49
MAX DELIVERY	600 KCAS CBU 24/29/49
MIN DELIVERY	175 KCAS
IN-FLIGHT OPTIONS	NONE
AUTHORIZED BOMBS	CBU 24/29/49 (/B, /B Mod, A/B, C/B)
ARMING AND FUNCTIONING DELAYS	
ARMING	ARMING DELAY IS 40 TO 60 PERCENT OF THE SELECTED FUNCTIONING DELAY.
FUNCTIONING	PREFLIGHT SELECTED: M907 E1 – 4 TO 92 SECONDS M907 E2 – 3 TO 92 SECONDS

DESCRIPTION

The M907 E1/E2 fuze provides an airburst capability for dispenser or cannister type weapons. Functioning accuracy is ±1 second at settings below 45 seconds and ±1.5 seconds at all settings above 45 seconds. Both the arming and functioning delay times commence simultaneously upon release.

M907 fuzes will not arm reliably at speeds less than 175 KCAS. If released in loft delivery, the trajectory airspeed of the bomb must not fall below 175 knots during the arming portion of travel or a dud will result.

PREFLIGHT CHECKS

Assure that the proper delay is set and lock screw is tight. Check arming wire rigging, Fahnestock clips, removal of fuze warning tags, and fuze condition. Ensure that arming vane is securely attached.

WARNING

An aperture in the body of the fuze (marked with the numeral 2) is covered with an aluminum foil seal. If brass plunger (slider assembly) protrudes through the foil the fuze is armed. Foil may be missing but as long as slider assembly does not protrude from fuze body the fuze is safe.

Fuze does not require impact for detonation and must not be used in any HE bomb.

REFERENCES

See References at the end of Fuzing and Fuze Limitations, Part 1 of this section.

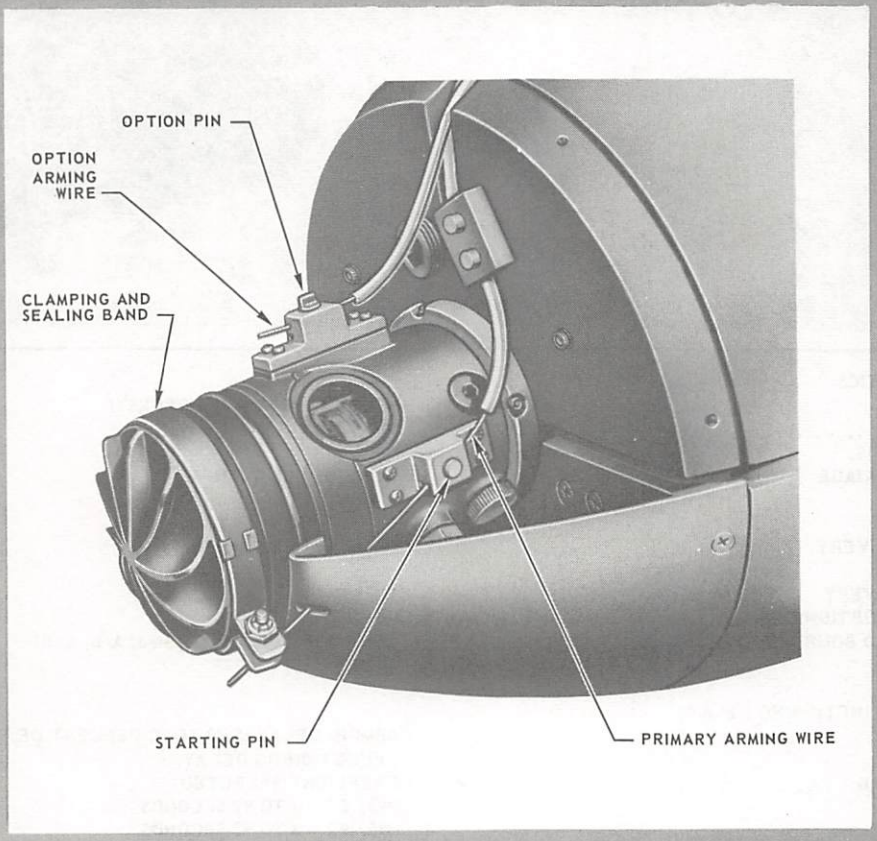
CONFIDENTIAL

FDB-1T-(116)

Figure 2-20 (C)

MK 339 MOD 0 FUZE

MECHANICAL-TIME (AIRBURST)



CHARACTERISTICS	
TYPE	MECHANICAL – TIME (AIRBURST)
LOCATION	NOSE
LIMIT SPEEDS	
MAX CARRIAGE	NO FUZE IMPOSED LIMITATIONS
MAX DELIVERY	NO FUZE IMPOSED LIMITATIONS
MIN DELIVERY	225 KCAS
IN-FLIGHT OPTIONS	None for ROCKEYE II Mod 2; Pilot selectable primary or option delay for ROCKEYE II Mod 3.
AUTHORIZED BOMBS	ROCKEYE II Mod 2 and Mod 3
ARMING AND FUNCTION DELAYS	
ARMING	1.1 Seconds
FUNCTIONING	Preflight selected – 1.2 to 50 seconds for Mod 2; primary and option delays each preflight selected – 1.2 to 50 seconds for Mod 3.

UNCLASSIFIED

FDB-1T-(117-1)

Figure 2-21 (U) (Sheet 1 of 2)

This page is UNCLASSIFIED

MK 339 MOD 0 FUZE-CONTINUED

DESCRIPTION

The MK 339 is a mechanical time fuze designed as a universal dispenser fuze. It provides an airburst capability for cluster and canister weapons. The MK 339 is presently authorized for use only with ROCKEYE II Mods 2 and 3.

The MK 339 has a fixed arming delay of 1.1 seconds and provision for resetting the primary and option functioning delay from 1.2 to 50 seconds. The settings are made on the two dials which appear in a window in the side of the fuze. The primary dial is black; the option dial is silver. The dials are not visible when installed in ROCKEYE II Mod 2.

When installed in ROCKEYE II Mod 2, only the option time setting of the MK 339 can be used. When installed in ROCKEYE II Mod 3, the pilot may select either the primary or the option setting.

ROCKEYE II Mod 2 is shipped in an all-up condition with a MK 339 fuze with a primary arming wire installed. The option arming wire is removed at the depot, thereby preselecting the option delay setting. The fuze is shipped with the option delay set at 4 seconds and the primary delay set at zero seconds. (See NAVAIR 11-5A-3, Interim change one.)

At release of ROCKEYE II Mod 2, withdrawal of the primary wire unlocks the arming vane, starts the timer and selects the option delay. The arming and functioning delays commence simultaneously at release. The timer functions with an accuracy of ± 1/2 percent.

ROCKEYE II Mod 3 is shipped in an all-up condition with a MK 339 fuze installed with a primary and an option wire. The fuze is shipped with the primary delay set at 1.2 seconds and the option delay set at 4 seconds. The time setting dials are visible through the nose-fairing observation window in ROCKEYE II Mod 3.

At release of ROCKEYE II Mod 3 withdrawal of the primary arming wire unlocks the arming vane, starts the timer and selects the primary delay. To select the option delay, both the primary and option wires must be withdrawn. The arming and functioning cycles are identical to those of ROCKEYE II Mod 2.

WARNING

Fuze does not require impact to function and should not be used in any HE bomb.

PREFLIGHT CHECKS

Only the arming vane will be clearly visible. Check rigging of primary arming wire (and option wire for the Mod 3). No fahnestock clips are used and arming wire should extend only 1/2-inch (± 1/8-inch) beyond the arming vane clamp.

WARNING

If the red-tipped plunger protrudes into the plastic bubble on the side of the fuze, the fuze is armed and should be considered dangerous. For fuze lots 16 and later a green foil disk is inserted in the plastic bubble; if the plunger has pierced the green foil, the fuze is armed. This bubble is visible through an observation window in the ROCKEYE II nose fairing.

REFERENCES

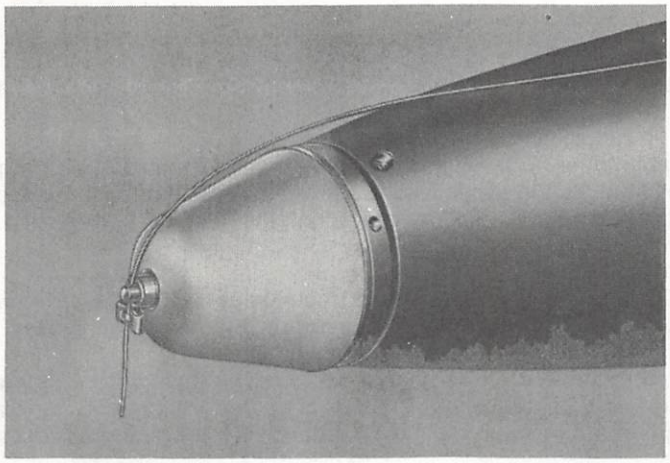
See Reference at the end of Fuzing and Fuze Limitations, part 1 of this section. Also NAVAIR 11-5A-17 for ROCKEYE II fuze details.

UNCLASSIFIED

FDB-1T-(117-2)

Figure 2-21 (U) (Sheet 2 of 2)

M20/20A1 SENSING ELEMENT



VT SENSING ELEMENT

TYPE	VT SENSING ELEMENT
LOCATION	NOSE
COLOR/MARKINGS	M20 – TAN M20A1 – DARK RED
IN-FLIGHT OPTIONS (SEE TABLE)	WITH M990 SERIES FUZES: VT (INST) OR NON-VT WITH MK 344/376 FUZES: VT (INST), VT WITH DELAY, OR NON-VT
IMPACT ANGLE	45° OR GREATER. BURST HEIGHT DECREASES AS ANGLE DECREASES.
BURST HEIGHT:	
HIGH SETTING	100 TO 160 FEET
LOW SETTING	20 TO 60 FEET
MAX CARRIAGE AND RELEASE SPEEDS	NO SENSING ELEMENT IMPOSED LIMITATIONS
MIN RELEASE ALTITUDE	2000 FT AGL
AUTHORIZED BOMBS	MK 80 LD SERIES AND M117

DESCRIPTION

The M20/20A1 is a proximity sensing device which provides an airburst capability for electrically fuzed non-retarded bombs. It employs a forward looking sensing lobe designed for the steep angle/high speed impacts common to free fall weapons. If used with retarded weapons or released below 2000 ft AGL a surface burst may result. The M20 and M20A1 are functionally identical.

Electrical energy for operating the sensing element is provided by a battery integral to the M20/20A1. This battery is mechanically initiated by the withdrawal of the arming wire from the nose of the M20 at weapon release. The battery can also be initiated electrically, (with the arming wire still in place), by application of an rf energy signal. However, the use of rf signals with any of the current electric tail fuzes is not authorized and, as a result, the M20/20A1 must always be initiated mechanically when VT operation is desired.

WARNING

Use care in selecting fuze option with Fuze Function Control Set AWW-1. Even if the weapon is dropped with the M20 arming wire in place for intended non-VT operation, the VT sensing element can still be electrically initiated by the inadvertent application of an rf signal. Under such a condition, the sensing signal can be reflected by the arming wire and cause the bomb to detonate at arming.

The M20 contains no explosive elements. Its only function is to provide an electric firing signal to the electric tail fuze. It cannot detonate the bomb until completion of the arming delay of the particular tail fuze which is installed.

CONFIDENTIAL

Figure 2-22 (C) (Sheet 1 of 3)

FDB-1T-(214-1)

M20/20A1 SENSING ELEMENT - CONTINUED

If the M20 fails to operate, the tail fuze serves as a back-up on impact. For most effective back-up operation it is recommended that the tail fuze be set for INST functioning.

Release altitude must be sufficient for tail fuze to arm at least 50 feet above desired burst height setting. Do not use M20 in retarded mode.

WARNING

- Observe minimum fuze arming times listed on Minimum Authorized Arming Times and Speeds figure.
- For normal delivery, do not release unretarded bombs closer than 200 msec. from the same rack or 100 msec. from different racks with M20 activated. Mutual interference between VT elements in bombs in close proximity can cause early bursts.

CAUTION

For CONLABS delivery, the same minimum interval restrictions noted above should be observed to minimize early bursts. At speeds of 400 KCAS or greater, shorter intervals may be used if necessary. Significant risk of early burst will still exist; however no danger of fragment damage to the aircraft will result if an early burst does occur.

PREFLIGHT CHECKS

Ensure that proper VT element is installed and all warning tags removed. Check that an arming wire is rigged in the nose and only one Fahnestock clip is attached.

Check for desired setting of the HI-LO switch.

REFERENCES

See References at the end of Fuzing and Fuze Limitations, part 1 of this section.

UNCLASSIFIED

FDB-1T-(214-2)

Figure 2-22 (U) (Sheet 2 of 3)

M20/20A1 SENSING ELEMENT-CONTINUED

AWW-1 OPTION SELECTOR SETTINGS

M990 PRESELECT FUZES (DC-ONLY): M990E-1, E-3, AND E-4

1. SET OPTION SELECTOR TO POSITION 'E' ONLY. THIS POSITION PROVIDES +300 VOLTS WHICH WILL ENERGIZE THE M990 FUZE BUT WILL NOT INITIATE THE M20/20A1 SENSING ELEMENT.
2. WITHDRAW THE ARMING WIRE FROM THE M20/20A1 AT WEAPON RELEASE. THIS INITIATES THE SENSING ELEMENT MECHANICALLY.

MK 344 – MK 376 FUZES

1. SET OPTION SELECTOR TO F, G OR H DEPENDING ON THE DELAY MODE DESIRED AS INDICATED BELOW. THE M20/20A1 CANNOT BE ELECTRICALLY INITIATED BY THE AWW-1.
2. WITHDRAW THE ARMING WIRE FROM THE M20/20A1 AT WEAPON RELEASE. THIS INITIATES THE SENSING ELEMENT MECHANICALLY.

OPTION SELECTOR SETTING	VT OPERATION	FUNCTIONING DELAY
F	MECH INITIATED	INST (0.0)
G	MECH INITIATED	DELAY (0.1)
H	MECH INITIATED	DELAY (0.015)

AWW-4 FUNCTION SWITCH SETTINGS

M990 PRESELECT FUZES (DC-ONLY) M990E-1, E-3 , AND E-4

1. SET FUNCTION SWITCH TO 'VT' ONLY. THIS PROVIDES +300 VOLTS WHICH WILL ENERGIZE THE M990 FUZE BUT WILL NOT INITIATE THE M20/20A1 SENSING ELEMENT.
2. WITHDRAW THE ARMING WIRE FROM THE M20/20A1 AT WEAPON RELEASE. THIS INITIATES THE SENSING ELEMENT MECHANICALLY.

MK 344/376 FUZES

1. SET FUNCTION SWITCH TO INST DLY 1 OR DLY 2 DEPENDING ON DELAY MODE DESIRED. DO NOT SELECT THE VT POSITION. THE M20/20A1 CANNOT BE ELECTRICALLY INITIATED BY THE AWW-4.
2. WITHDRAW THE ARMING WIRE FROM THE M20/20A1 AT WEAPON RELEASE. THIS INITIATES THE SENSING ELEMENT MECHANICALLY.

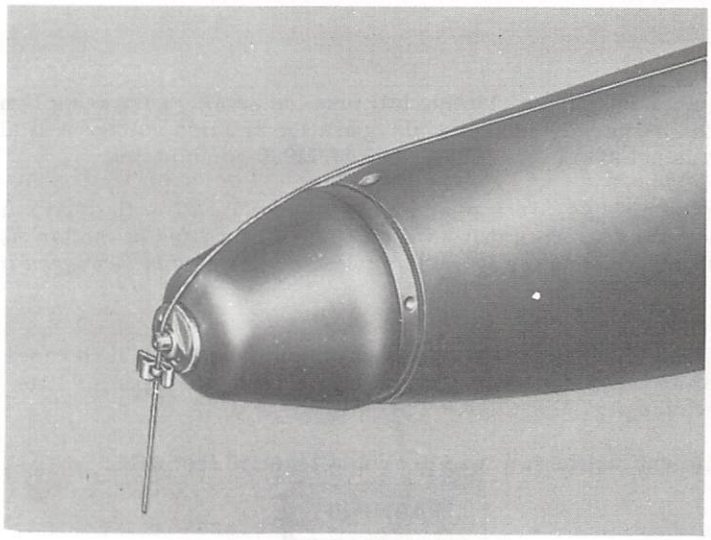
NEW NEW NEW NEW NEW NEW

UNCLASSIFIED

Figure 2-22 (U) (Sheet 3 of 3)

FDB-1T-(214-3)

MK 43 TARGET DETECTING DEVICE



CHARACTERISTICS	
TYPE	VT SENSING ELEMENT
LOCATION	NOSE
COLOR MARKINGS	DARK GREEN
IN FLIGHT OPTIONS (SEE TABLE)	WITH MK 344/376 FUZES: VT (INST), VT WITH DELAY, OR NON-VT WITH M990 SERIES FUZES: VT (INST)
IMPACT ANGLE	0° TO 90° (OPTIMUM BETWEEN 10° AND 60°)
BURST HEIGHT	16 FEET (NOMINAL). DECREASES SLIGHTLY AS IMPACT ANGLE INCREASES.
LIMIT SPEEDS	NO TARGET DETECTING DEVICE IMPOSED LIMITATIONS
AUTHORIZED BOMBS	MK 80 LD SERIES, SNAKEYE I, M117

DESCRIPTION

The MK 43 is a proximity sensing device which provides an airburst capability for electrically fuzed bombs. It employs a side-looking sensing lobe designed primarily for the shallow angle/low speed impacts common to retarded weapons. It can be used with low drag weapons but burst heights will be slightly lower than nominal.

NEW

The MK 43 can be initiated either mechanically by withdrawal of the arming wire or electrically by application of +300 volts. The arming wire is an alternate means of initiation and is not a safing device. The MK 43 can be electrically initiated with the arming wire in place. (See AWW-1 and AWW-4 OPTION SELECTOR SETTINGS.)

WARNING

On all releases in which the VT element is to be actuated either mechanically or electrically, the arming wire (if one is rigged) must be withdrawn from the MK 43 for safety reasons. If the arming wire is dropped with a weapon in which the VT element has been electrically actuated, the sensing signal can be reflected by the arming wire and detonate the bomb at fuze arming.

The MK 43 contains no explosive components. Its only function is to provide an electric firing signal to the electric tail fuze. It can not detonate the weapon until completion of the arming delay of the particular tail fuze which is installed.

CONFIDENTIAL

FDB-1T-(118-1)

Figure 2-23 (C) (Sheet 1 of 3)

[redacted]

MK 43 TARGET DETECTING DEVICE - CONTINUED

When the MK 43 is used with an M990 series electric tail fuze, *an arming wire is neither required nor should be rigged to the MK 43.* The M990 requires +300 volts for operation and this voltage will always actuate the MK 43. As a result, a non-VT option is not available with the MK 43/M990 combination.

When the MK 43 is used with the MK 344/376 fuze, options of non-VT, VT with delay, and VT (INST) are available. Only the VT *with delay* option requires that an arming wire be rigged to the MK 43. (See MK 344/376 Fuze.) For all other options, *an arming wire is neither required nor should be rigged to the MK 43.* (See WARNING.)

If the MK 43 fails to operate, the tail fuze serves as a back-up on impact. In such cases the selected functioning delay of the tail fuze will operate normally. For most effective back-up operation it is recommended that the tail fuze be set for INST functioning.

Release altitude must be sufficient for the tail fuze to arm at least 50 feet AGL.

WARNING

- Observe minimum fuze arming times listed in Minimum Authorized Arming Times and Speeds figure.
- For normal delivery, do not release bombs from the same or different racks at closer than 60 msec. unretarded or 200 msec. retarded with the MK 43 activated. Mutual interference between VT elements in bombs, in close proximity, can cause early bursts.

CAUTION

For CONLABS delivery, the same minimum interval restrictions noted above should be observed to minimize early bursts. At speeds of 400 KTAS or greater, shorter intervals may be used if necessary. Significant risk of early burst will still exist; however, there is no danger of fragment damage to the aircraft if an early burst does occur.

PREFLIGHT CHECKS

Assure that the proper VT element is installed. Check that either an arming wire or a safety clip is rigged in the nose and all warning tags are removed.

When an arming wire is used, only one Fahnestock clip is attached.

REFERENCES

See References at the end of Fuzing and Fuze Limitations, part 1 of this section

UNCLASSIFIED

FDB-1T-(118-2)

Figure 2-23 (U) (Sheet 2 of 3)

MK 43 TARGET DETECTING DEVICE-CONTINUED

AWW-1 OPTION SELECTOR SETTINGS

M990 PRESELECT FUZES (DC ONLY): M990 E-1, E-3 AND E-4
1. SET SELECTOR TO POSITION E ONLY.
2. NON-VT OPTION NOT AVAILABLE WITH THE MK 43/M990 COMBINATION.

MK 344-MK 376 FUZES

OPTION SELECTOR SETTING	VT OPERATION	FUNCTIONING DELAY	ARMING DELAY
E	YES-ALWAYS	INST (0.0)	NOTE 2
F	NO	INST (0.0)	NOTE 2
G	NO – NOTE 1	DELAY (0.1)	NOTE 2
H	NO – NOTE 1	DELAY (0.015)	NOTE 2

NOTE 1: WITH THIS SETTING, MK 43 MUST BE MECHANICALLY INITIATED TO OBTAIN *VT WITH DELAY* MODE.

NOTE 2: ARMING DELAY IS AUTOMATICALLY SELECTED BY THE FUZE AS FOLLOWS:

	RETARDED	UNRETARDED
MK 344	*	5.5
MK 376	2.6	10.0

* NOT AUTHORIZED

AWW-4 OPTION SELECTOR SETTINGS

NEW NEW NEW NEW NEW NEW

M990E1/E3/E4 (DC ONLY) WITH MK 43 TDD INSTALLED
1. Set selector switch to VT; (+300 volts is applied to TDD).
2. Non-VT operation not available with M990 when TDD is installed in weapon.

MK 344/MK 376 FUZES WITH MK 43 TDD INSTALLED

AWW-4 SELECTOR Switch	VT OPERATION Mode	FUNCTIONING DELAY	ARMING DELAY
VT	Yes	VT with INST. backup	5.5/Mk 344
INST	No	INST	2.6 or 10/Mk 376
DLY 1	*	0.015	
DLY 2	*	0.10	

* VT must be mechanically initiated by pulling TDD arming wire. This provides VT operation with indicated functioning delay.

UNCLASSIFIED

FDB-1T-(118-3)

Figure 2-23 (U) (Sheet 3 of 3)

ROCKET FUZE COMPATIBILITY & APPLICATION

FUZE	LOCATION/TYPE	ARMING ACTION[1]	ARMING TIME/ DISTANCE	FUNCTIONING	USED WITH	ROCKET TYPE
M414A1/ MK 93	NOSE–VT	> 13 G'S ACCELERATION + TIME + BURNOUT	0.7 SECOND/ 400' TO COMMIT, 1000' TO BURNOUT	AIRBURST	MK 24 HE MK 32 ATAP MK 34 W P SMOKE MK 63 ANTI–PERSONNEL	5.0"
MK 188 MOD 0	NOSE–IMPACT	> 13 G'S ACCELERATION + TIME	0.7 TO 0.9 SEC/ 400' TO 800'	IMPACT INST.	MK 24 HE MK 32 ATAP MK 34 W P SMOKE	5.0"
MK 191 MOD 1	BASE–IMPACT	> 13 G'S ACCELERATION + TIME	0.8 TO 1.0 SEC/ 400' TO 1000'	IMPACT .004 SEC. DELAY	MK 24 HE	5.0"
MK 193 MOD 0	NOSE–TIME	> 13 G'S ACCELERATION + TIME + BURNOUT	0.7 SECOND/ 400' TO COMMIT, 1000' TO BURNOUT	15 SEC (+2–1) SEC.	MK 33 FLARE	5.0"
MK 352/ FMU 90	NOSE–IMPACT	> 13 G'S ACCELERATION + TIME	660 TO 1180 FT.	IMPACT INST.	MK 24 HE MK 32 ATAP MK 34 W P SMOKE MK 63 ANTI–PERSONNEL	2.75" (REQUIRES BBU 15B ADAPTER FOR 5.0")
MK 176 MOD 1	NOSE–IMPACT	> 13 G'S ACCELERATION + TIME	400 FT. TO 1300 FT.	IMPACT .0003 DELAY	MK 1 HE	2.75"
MK 178 MODS 1 AND 2	NOSE–IMPACT	> 13 G'S ACCELERATION + TIME	400 FT. TO 1300 FT.	IMPACT INST.	MK 1 HE	2.75"
MK 181	NOSE–IMPACT	> 13 G'S ACCELERATION + TIME	330 FT. TO 660 FT.	IMPACT INST.	MK 5 ATAP (SHAPED CHARGE)	2.75"
MK 427 AND MK 352 MOD 2	NOSE–IMPACT	> 13 G'S ACCELERATION + TIME	800 FT TO 1250 FT.	IMPACT INST.	MK 1 HE MK 64 GP MK 67 SMOKE MK 151 GP MK 156 SMOKE	2.75"

[1] G–FORCES REQUIRED TO CAUSE ARMING WILL VARY WITH MANUFACTURING TOLERANCES. VALUES SHOWN ARE MINIMUM.

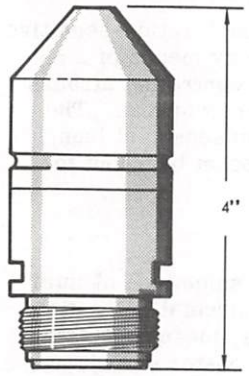
KEY

AP – Anti–Personnel
ATAP – Anti–Tank Armor Piercing
BD – Base Detonating
GP – General Purpose
HE – High Explosive
M – Model
Mk – Mark
PD – Point Detonating
VT – Variable Time (Proximity)
WP – White Phosphorus

UNCLASSIFIED
FDB–IT–(119)

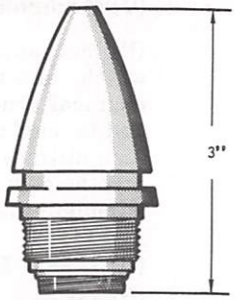
Figure 2-24 (U)

ROCKET FUZES



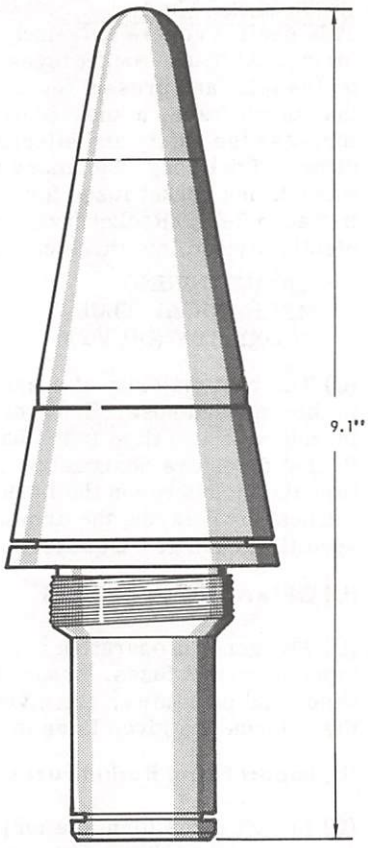
FUZE M 427

TYPE – IMPACT
LOCATION – NOSE
DELAY...INST.
TARGET...GROUND OR WATER.



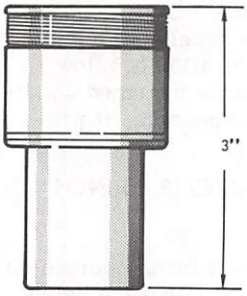
FUZE MK 176 AND 178

TYPE – IMPACT
LOCATION... NOSE
DELAY...
176 – .0003 SEC.
178 – INST.
TARGET... GROUND BURST, GENERAL APPLICATION.
WILL NOT DETONATE ON WATER OR WITH IMPACT ANGLES LESS THAN 10 TO 15 DEGREES.



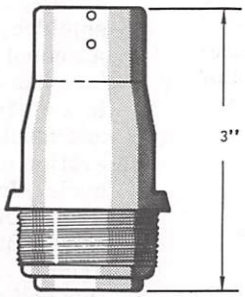
FUZE MK 93 (M414A1)

TYPE – VT (AIRBURST)
LOCATION... NOSE
DELAY... NOT APP.
TARGET... GROUND
20 DEGREE TO 40 DEGREE IMPACT ANGLE REQUIRED FOR AIRBURST.
IMPACT BACKUP CAN BE RIPPLE FIRED.



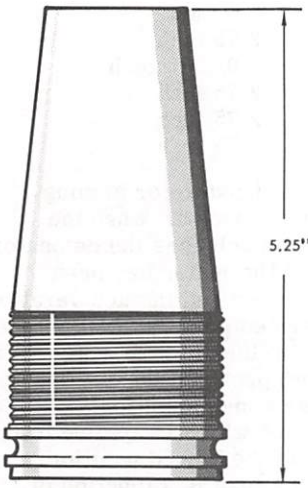
FUZE MK 193

TYPE – AIRBURST MECHANICAL
LOCATION...NOSE
DELAY...FIXED 15 SEC. NOMINAL
TARGET...AIRBURST (FLARE ACTUATION).
NO IMPACT BACKUP FUNCTION.



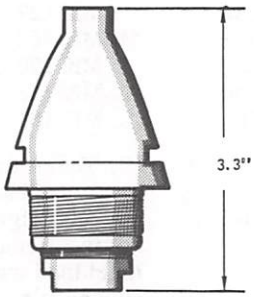
FUZE MK 352

TYPE – IMPACT
LOCATION... NOSE
DELAY... INST.
TARGET... GROUND OR WATER.
PREFERRED FOR APPLICATION WHERE RELIABILITY IS REQUIRED AGAINST SOFT TARGETS WITH SHALLOW IMPACT ANGLE.



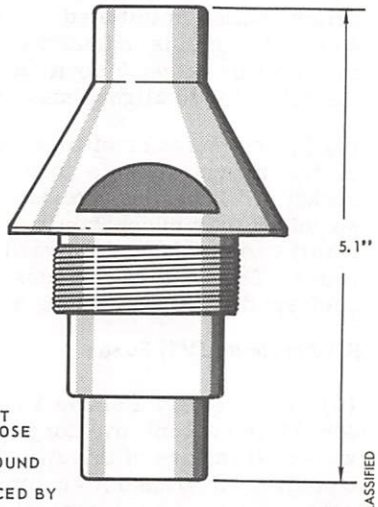
FUZE MK 191

TYPE – IMPACT
LOCATION... BASE
DELAY.. .004 SEC.
TARGET... GROUND PENETRATION.
NOT RELIABLE ON WATER TARGETS.



FUZE MK 181 MOD 0

TYPE – IMPACT (SHAPED CHARGE)
LOCATION... NOSE
DELAY... INST.
TARGET... GROUND BURST, LIGHT TANKS, ARMORED VEHICLES, ETC.
WILL NOT DETONATE ON WATER OR WITH IMPACT ANGLES LESS THAN 10 TO 15 DEGREES. SHAPED CHARGE MUST IMPACT BETWEEN 30 AND 90 DEGREES OF THE TARGET TO BE PENETRATED.



FUZE MK 188

TYPE – IMPACT
LOCATION... NOSE
DELAY... INST.
TARGET... GROUND OR WATER.
TO BE REPLACED BY MK 352.

UNCLASSIFIED

FDB-1T-(221)

Figure 2-25 (U)

(U) ROCKET FUZES

(U) GENERAL

This section covers 2.75-inch and 5.0-inch rocket fuzing. Although rocket fuzes impose less demands on the pilot and present fewer delivery restrictions than bomb fuzes, a knowledge of rocket fuzing can increase the safety and effectiveness of rocket handling and delivery. Summary data for current forward-firing rocket fuzes for jet aircraft are given in figure 2-24. Rocket fuzes may be most conveniently divided into three categories:

IMPACT FIRING
MECHANICAL TIME
PROXIMITY (OR VT)

(U) The vast majority of rocket fuzes are mounted in the warhead nose. However, one fuze in present inventory is installed in the base of the warhead. Rocket fuzes are designed to provide a safe separation distance between the launching aircraft and the warhead by delaying the arming of the fuzes for a specific length of time after launch.

(U) OPERATING PRINCIPLES

(U) The general operating principles of the three types of rocket fuzes, impact firing, mechanical time, and proximity, are given below. Details of these fuzes are given later in this section.

(U) Impact Firing Rocket Fuzes

(U) Impact fuzes form the majority of rocket fuzes presently in service. They function when the rocket strikes the target. The firing train is initiated through crushing and compression. (The MK 191 base impact fuze is the exception, and will be covered later).

(U) The arming cycle is initiated when the rocket is launched. Acceleration is sensed by a setback weight in the fuze. As the weight moves aft under acceleration along the longitudinal axis of the fuze, the fuze arming action is initiated. Arming continues so long as acceleration is maintained and the weight is held in the aft or *set back* position. This action allows the detonator to align, thus arming the fuze.

(U) The combination of time and a registered acceleration provides a safe arming separation of the rocket and launching aircraft. If the acceleration is sustained only momentarily, the set-back weight returns to the normal forward position and stops the timer. This feature provides safety if the round is accidentally dropped during handling.

(U) Proximity (VT) Fuzes

(U) There is only a single VT rocket fuze (M414A1/MK 93) in current inventory for jet aircraft. The air-burst feature of this fuze is controlled by a self-contained RF transmitter similar to those used in VT sensing elements for general-purpose MK 80 series bombs. The sensitivity of the fuze has been held at a fairly low level to preclude mutual interference between rockets when ripple-fired. The sensitivity is therefore too low to be effective against other aircraft and the fuze is thus restricted to an air-to-surface role.

(U) Mechanical Time Fuzes

(U) Mechanical time fuzes are acceleration-sensitive which, at a set distance, initiate by means of a mechanical timer. This provides a controlled airburst and is used only in the MK 33 flare warhead. The fuze utilizes both the acceleration sensed at launch and the deceleration sensed at rocket burn-out to complete the firing cycle.

(U) SAFETY FEATURES

(U) All rocket fuzes depend upon some type of internal safety features to prevent accidental detonation. Present fuzes are detonator-safe, meaning that the detonator is out of line with the booster until fuze arming occurs, or the detonator is mechanically shielded, thus blocking its flash path to the booster. As noted above, arming can not take place until the fuze has sensed the normal acceleration experienced in a clean rocket launch. Additionally, proximity and mechanical time fuzes utilize the normal deceleration of motor burn-out to complete the arming cycle. In general, rocket fuzes are safe if dropped. Even though the fuze experiences acceleration, the acceleration is not of sufficient duration to allow arming. The fuze then returns to its unarmed condition and although not necessarily operable, it presents no further abnormal hazard.

(U) POINT DETONATING NOSE FUZES (2.75 INCH & 5.0 INCH)

(U) All current impact firing rocket fuzes operate on similar principles. Therefore, the coverage below is typical of the following fuzes:

Type	Rocket
MK 188	5.0 inch
MK 427	2.75 inch
MK 352	5.0/2.75 inch
MK 176	2.75 inch
MK 178	2.75 inch
MK 181	2.75 inch

(U) These fuzes use an unbalanced-rotor arming system. The setback weight moves aft when the rocket is ignited. This action releases the detonator rotor. Because a portion of the motor has been machined away, it is unbalanced and the acceleration causes it to rotate to the armed position. An escapement mechanism is geared to the rotor as a restraining device. The escapement prevents the rotor from snapping immediately to the armed position. But the greater the accelerating force which is applied to the rotor, the faster it moves to the armed position. Thus, the arming time of the fuze is a function of acceleration. Minor variations in rocket thrust and burning characteristics are therefore evened out. The fuze rotor is held in the armed position by the setback weight and a separate detent after it has fully rotated.

(U) The M427 fuze is similar in arming method but it differs in its physical details. A striker body mounted in front of the firing pin body provides in-

creased reliability in shallow-angle impacts. On impact, the striker body collapses; the striker body pin then impacts the firing pin body along its longitudinal axis regardless of the angle of target impact.

(U) The MK 352 Mod 2 is similar to the M427 in its design and tactical application. However, it is preferred over the M427 for use against soft targets and extreme shallow-angle impacts. The MK 352 Mod 2 uses a *pill box* nose envelope as contrasted to the truncated cone nose on the M427.

(U) BASE DETONATING FUZES (MK 191 MOD 1; 5.0 INCH ROCKET)

(U) Base detonating fuzes are a type of impact firing fuze, similar in function to point detonating fuzes. A base detonating fuze is located in the base of the warhead and is designed to function instantaneously on impact or after a delay. The MK 191 Mod 1 is the only base detonating fuze presently in service and is used only with ZUNI. It is acceleration-armed and has an internal magnetic generator which furnishes electrical energy for fuze detonation. Two internal arming mechanisms in tandem provide safety for the fuze until armed. The forward arming mechanism serves as an out-of-line explosive train. It contains a detonator which lines up with the booster lead-in under sustained acceleration. The aft arming device has an additional out-of-line channel (without explosives) similar to the forward arming device. Operation of the aft arming mechanism also severs a shorting wire to the magnetic generator.

(U) Fuze impact causes the magnetic generator to send an electrical impulse to the primer. The flash from the primer is then transmitted to the detonator, tetryl lead-in and booster. The 0.004-second delay of the MK 191 Mod 1 and its location in the base of the warhead provides better target penetration. The fuze is not reliable against water targets. When penetration of a hard target is desired, the nose fuze of the warhead is replaced with a hardened steel ogive.

(U) MECHANICAL TIME FUZES (MK 193 MOD 0)

(U) Mechanical time fuzes are acceleration-sensitive fuzes which detonate at a set distance, initiate the firing train by means of a mechanical timer. They do not require impact to operate. The MK 193 Mod 0 is the only mechanical-time rocket fuze presently in service use. It is used only with the MK 33 Mod 1 flare warhead. The functioning delay of the MK 193 is 15 seconds. The MK 193 is similar in arming action to other acceleration-armed fuzes.

(U) VT (PROXIMITY) FUZES

(U) VT rocket fuzes (of which the MK 93/M414A1 is the only one currently in service) provide an air burst in air-to-ground rocket attack. These fuzes are not suitable for air-to-air combat because of the lack of sensitivity required for this application. The M414A1/MK 93 is armed by acceleration. When acceleration is sensed, a firing pin is released which initiates a thermal battery. This battery provides electrical power for operation of the VT circuitry. This first step in the arming sequence occurs in approximately 0.5 to 0.7 second after launch. If acceleration is sustained for at least 400 feet, the arming mechanism causes the barrier containing the lead charge to be unlatched, thus committing the fuze to arm. Arming occurs at rocket burnout, when deceleration causes the detonator circuit to be closed and the electronics package output is placed in line with the explosive train. The sensitivity of the fuze provides a burst 10 to 50 feet above ground with approach angle optimized for maximum burst height at 20° to 40°. Rockets equipped with this fuze can be ripple-fired and are not highly sensitive to mutual interference.

(U) ROCKET WARHEADS

(U) The following is a summary of the operational characteristics of warheads used on 2.75 inch and 5.0 inch rockets (figure 2-26). For a more detailed description refer to NAVAIR 11-85-5.

(U) Rocket warheads are classified according to function as follows:

HE frag
HEAT (high explosive anti-tank)
HEAT/APERS (high explosive anti-tank/anti-personnel)
HE GP
Smoke
Flare

(U) Warheads currently in service are categorized as follows:

2.75 inch	5.0 inch	Type
- -	MK 63	HE frag
MK 5	- -	HEAT
- -	MK 32	HEAT/APERS
MK 1, MK 151	MK 24	HE GP
M156	MK 34	Smoke
- -	MK 33	Flare

(U) HIGH EXPLOSIVE GP

(U) HE GP M151

(U) This warhead is used with the 2.75 inch rocket against personnel and soft targets such as parked aircraft, personnel carriers, radar emplacements, etc. The warhead contains 2.3 lbs. of Comp B-4 and is shipped with the M427 fuze installed. Construction is of soft cast iron, and total weight is about 9.5 lbs.

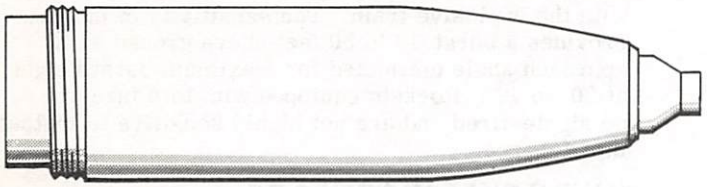
(U) HE GP MK 1 All Mods

(U) The MK 1 is used with the 2.75 inch rocket and is similar in function to the M151. It uses the MK 176, MK 178, M427, MK 352 and FMU-90 fuzes. There are five mods, differing in physical construction and a sixth (Mod 2) which is an inert-loaded training warhead. The warhead is filled with 1.4 lbs. of either HBX-1 or Comp B explosive. Total weight is approximately 6.5 lbs.

(U) MK 24

(U) The MK 24 general purpose warhead is used on the 5.0 inch rocket and is designed to fill a variety of tactical applications. The MK 188 point detonating nose fuze (or the MK 352/FMU-90/B) with adapter is used. The MK 191 base impact fuze is shipped

ROCKET WARHEADS



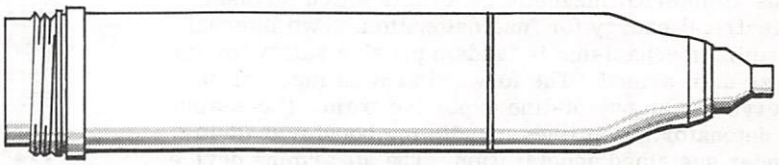
5.0-INCH ROCKET WARHEAD MK 24 MOD 0

CHARACTERISTICS
MK 24 MOD 0 (HE)

Length	17.850 Inches
Weight	50.40 pounds
Filler	
Type	Comp B
Weight	9.10 Pounds
Nose Fuze MK – Mod	188–0
Nose Ogive	458162
Base Fuze MK – Mod	191–1

CHARACTERISTICS
MK 32 MOD 0 (ATAP)

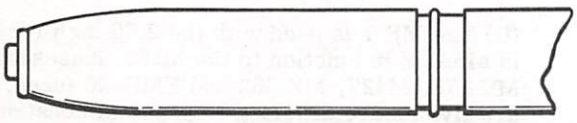
Length (Approx)	29.112 Inches
Weight	45.76 Pounds
Filler	
Type	Comp B
Weight	15.00 Pounds
Initiator–Booster Assembly	
Type	Tetryl
Weight	0.30 Pounds
Nose Fuze MK – Mod	188–0



5.0-INCH ROCKET WARHEAD MK 32 MOD 0 (ATAP)

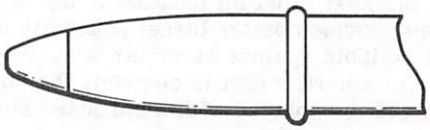
5.0-INCH PRACTICE WARHEADS

MK 62 MOD 0 WARHEAD
Length..... 20.50 Inches
Weight..... 46.30 lbs.

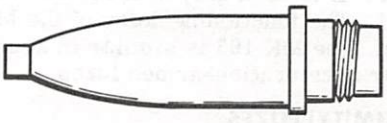


MK 6 MOD 7 ROCKET WARHEAD, PRACTICE
Length..... 19.75 Inches
Weight..... 47.90 lbs.

2.75-INCH WARHEADS



MK 1 WARHEAD
Length..... 10.99 Inches
Weight..... 6.47 lbs.



MK 5 WARHEAD (HEAT)
Length..... 11.08 Inches
Weight..... 6.60 lbs.

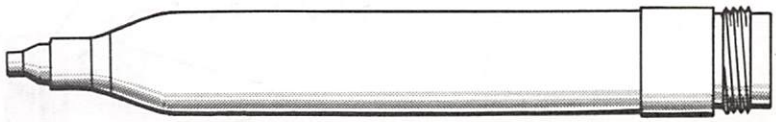
UNCLASSIFIED

FDB–1T–(238–1)

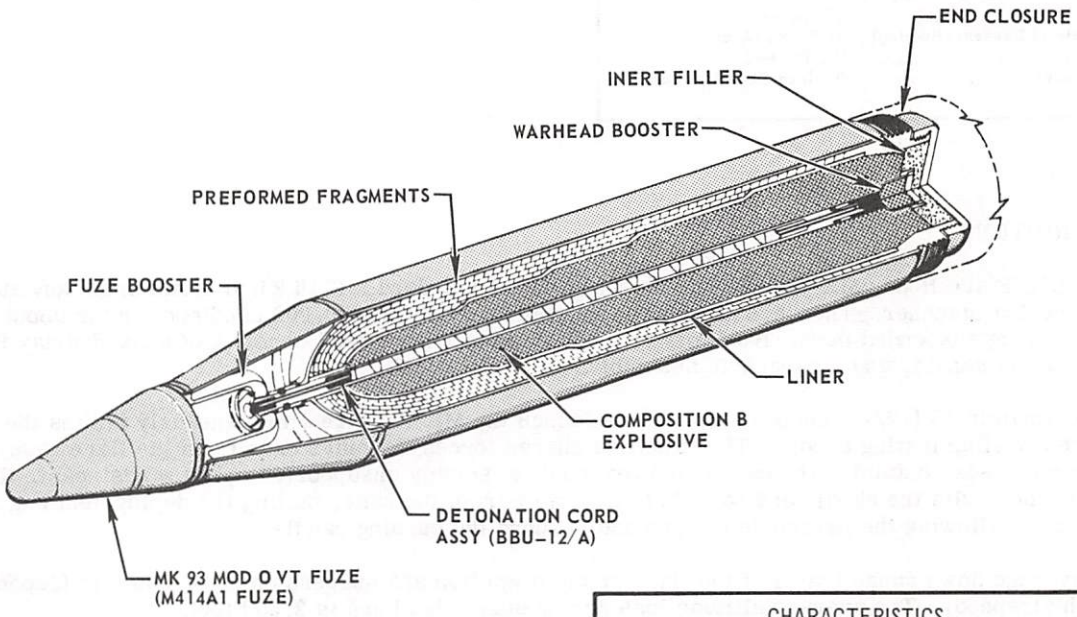
Figure 2-26 (U) (Sheet 1 of 3)

ROCKET WARHEADS-CONTINUED

CHARACTERISTICS	
Lot No. Prefix	RHCG
Overall Shipping Length	40.457 Inches
Nominal Weight	51.94 lbs.
Filler	
Type	PWP
Weight	19.36 lbs.
Nose Fuze MK – Mod	188–0



5.0-INCH ROCKET WARHEAD MK 34 MOD 0 (SMOKE)



5.0-INCH ROCKET WARHEAD MK 63 MOD 0 (VCMR)

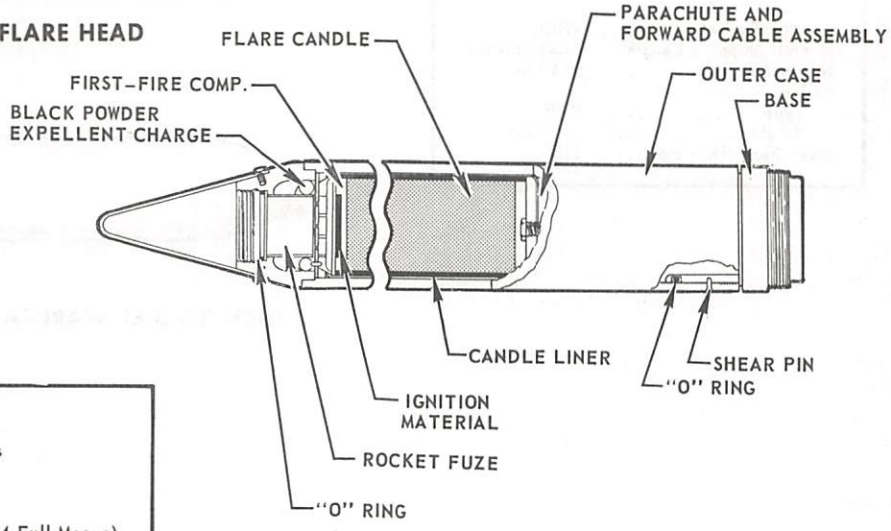
CHARACTERISTICS	
Warhead type	HE fragmentation
Length with fuze	35.25 Inches
Diameter	5 Inches
Weight with fuze	58 lbs.
Fuze type	VT, MK 93 MOD 0 (M414A1)
Explosive type	Comp B
Explosive weight	15 lbs.
Booster type	CH–6
Booster weight	21 grams

FDB–1T–(238–2)

Figure 2-26 (U) (Sheet 2 of 3)

ROCKET WARHEADS-CONTINUED

5.0-INCH ZUNI MK 33 MOD 1 FLARE HEAD



CHARACTERISTICS

Length	33.5 Inches
Diameter	5.0 Inches
Weight (W/O ZUNI Motor)	45.9 lbs.
Weight of ZUNI Motor	56.6 lbs.
Candle power (Nominal)	1,000,000 (4 Full Moons)
Burn Time (Average)	136 Seconds
Rate of Descent (Burning)	17.9 FPS (Average)
Fuze	MK 193 Mod 0
Rocket	5.0 Inch ZUNI (MK 16)

DESCRIPTION

The ZUNI Flare Head, MK 33 Mod 1 is launched by the standard MK 16 ZUNI motor from any authorized ZUNI rocket launcher. The flare head provides approximately 1,000,000 candlepower for about 136 seconds during suspended burn. Basically, the MK 33 Mod 1 flare head consists of a fixed-delay fuze, an illuminating candle, and a parachute assembly.

Approximately 15 (+2/-1) seconds after ZUNI launch the MK 193 fuze simultaneously ignites the expelling charge and illuminating candle. The expelling charge forces the outer case from the flare base leaving the two inner cases containing the candle and parachute assembly unsupported in the windstream. The windstream then pulls the candle and parachute assembly from the base, pulling the deployment bag from the parachute, allowing the parachute to open and suspend the burning candle.

The average down range travel of the flare prior to ignition and suspension is 24,000 feet (depending on launch airspeed). The average altitude loss during suspended burn is 2,500 feet.

All procedures and precautions attendant to ZUNI rockets apply to the MK 33 Mod 1 flare head.

REFERENCES

1. DESCRIPTION AND OPERATION . . . . . NAVWEPS OP 2213
2. LOADING PROCEDURES . . . . . NAVWEPS 01-245FDB-75
3. EXTERNAL STORES LIMITATIONS . . . . . APPENDIX A
4. EMPLOYMENT TACTICS . . . . . SECTION II, PART 2
5. CURRENT AAB's

UNCLASSIFIED

FDB-1T-(238-3)

Figure 2-26 (U) (Sheet 3 of 3)

with the warhead and may be used in conjunction with a steel nose plug to provide target penetration. The MK 24 warhead may also be VT fuzed for use against personnel and a variety of light targets. The MK 24 is filled with 9.1 lbs. of Comp B explosive.

(U) HIGH EXPLOSIVE FRAG (MK 63)

(U) This warhead is used with the 5.0 inch ZUNI rocket. Its design provides a high density, uniform frag pattern particularly when used with a VT fuze for airburst. Overall weight is approximately 55 lbs. Filler is approximately 15 lbs. of Comp B. It is primarily used against personnel and light material in the VT mode although it may be used for surface bursts. The VT fuze is the MK 93 (M414A).

(U) The MK 63 Mod 0 warhead is designed for use with the MK 93 VT (M414A1) proximity fuze. This is the only fuze that can be used with this warhead. The MK 93 fuze functions at a height above the terrain that depends on (1) rocket velocity, (2) rocket entry angle, and (3) the reflection coefficient of the terrain. In general, it will function at a higher altitude above water than it will above dry land. Normal fuze functioning altitudes are 25 to 40 feet.

(U) HEAT (MK 5)

(U) The MK 5 high-explosive anti-tank warhead is used with the 2.75 inch rocket against lightly armored vehicles. It uses the MK 181 fuze. Overall weight is 6.6 lbs. with 0.9 lbs. of Comp B filler. It has only limited effectiveness against other targets because of the shaped charge effect.

(U) HEAT/APERS (MK 32)

(U) The MK 32 warhead is used in 5 inch rockets. For anti-tank applications, it is used with the MK 188 fuze. An interior waffled plastic liner produces maximum fragmentation when used in anti-personnel application. Maximum fragmentation is produced by proximity fuzing with the VT MK 93 (M414A1). The MK 32 warhead weighs approximately 45 lbs. and contains 15 lbs. of Comp B explosive.

(U) SMOKE WARHEADS

(U) Smoke warheads use a white phosphorus filler and are used for target marking. Three smoke warheads are currently available.

(U) M156

(U) The M156 is used with the 2.75 inch rocket. It contains two lbs. of WP filler with a Comp B booster. The warhead is delivered with the M427 fuze installed. Total weight is approximately 9.7 lbs.

(U) MK 67

(U) The MK 67 is similar in function to the M156 but uses a lighter case. It is filled with 2.6 lbs of WP and a Comp B booster. Overall weight is approximately 5.2 lbs. The M427 fuze is standard.

(U) MK 34

(U) The MK 34 warhead is used in 5.0 inch ZUNI. It contains 19 lbs. of plasticized white phosphorus (PWP) and a Comp B booster. The MK 188 nose fuze is used. Total weight is approximately 52 lbs.

(U) FLARE WARHEAD (MK 33)

(U) The MK 33 warhead is used with 5.0 inch rockets for target illumination. The MK 193 nose fuze provides a 15 sec. (nominal) actuation delay. Fuze operation simultaneously initiates the illuminating compound (candle) and blows the outer case forward leaving the candle and parachute unsupported in the wind stream. As the rocket continues in flight, the bag covering the parachute is stripped off, allowing it to deploy.

(U) ROCKET MOTORS

(U) 2.75-INCH FFAR

(U) The 2.75-inch folding fin aircraft rocket (figure 2-27) is designed for air-to-ground attack. It is adapted to use a high-explosive head, a high-explosive antitank head, or an inert head for practice. The rocket is electrically ignited when the bomb release button is pressed. The folding fins are opened by gas pressure as the rocket leaves the launcher. For Fuze description, see Rocket Fuzes part 1 of this section.

(U) 5.0-INCH (ZUNI) FFAR

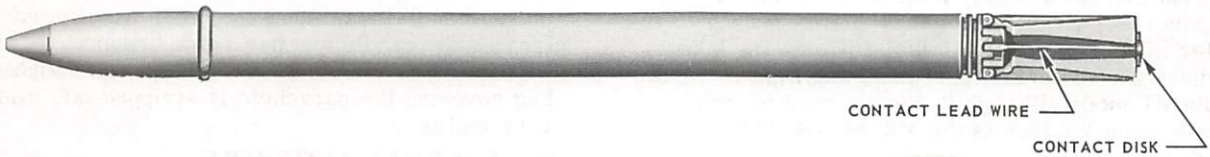
(U) The 5.0-inch Zuni rocket (figure 2-27) is a high-explosive munition which offers several advantages over other air-to-ground rockets. The peak velocity of the Zuni is extremely fast, resulting in a very short time of flight. Gravity and wind effects are thus very small, contributing to a high degree of accuracy. The high velocity also produces considerable target damage due to shock effect. The rocket consists of a motor and warhead. At the aft end of the motor are four blast-actuated fins which extend when the rocket leaves the launcher. For Fuze description, see Rocket Fuzes part 1 of this section.

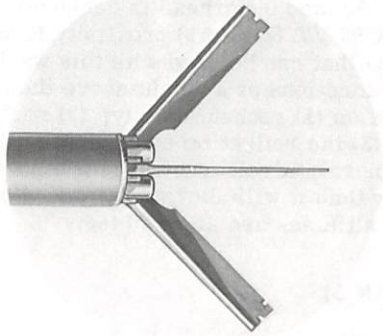
(U) REFERENCES

a. Technical details of fuzes and accessories.	NAVAIR 11-5A-17
b. Arming Wire installation.	Conventional Weapons Loading Manual NAVAIR 01-245FDB-75
c. Details of Bombs and Accessories	NAVAIR 11-5A-17
d. Aircraft Rockets	NAVAIR 11-85-5
e. CBU Weapons	NAVAIR 11-5A-1
f. Rockeye II and Mk 339	NAVAIR 11-5A-3
g. Destructor Mk 36/40	NAVORD OP 3529
h. Retarded Weapons (Snakeye)	NAVAIR 11-5A-27/ 11-5A-17 Rev 1

ROCKET MOTORS

2.75-INCH FFAR



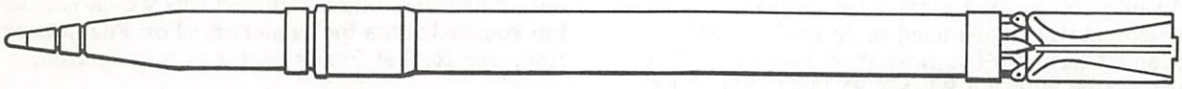


MK 40 ROCKET MOTOR

CHARACTERISTICS

Weight (less warhead)	11.22 Pounds
Length (less warhead)	39.30 Inches
Diameter	2.75 Inches

5.0-INCH (ZUNI) FFAR



MK 16 ROCKET MOTOR

CHARACTERISTICS

Weight (less warhead)	56.6 Pounds
Length (less warhead)	75.0 Inches
Diameter	5.0 Inches

UNCLASSIFIED

FDB-1T-(237)

Figure 2-27 (U)

NAVIGATION

(U) RADAR NAVIGATION

(U) GENERAL

(U) The AN/APQ-72 and AN/APG-59 radar systems are designed primarily for airborne detection and tracking; therefore, the radar system has some limitations when utilized for navigation and mapping. Thorough understanding of these limitations is essential to effective system employment.

(U) CHECKPOINT SELECTION

(U) Radar display orientation requires the selection of radar significant checkpoints that present an identifiable contrast. Radar contrast is provided by coast line, islands, rivers, towns, dams, bridges, and lakes. Flat land, jungle areas, mountains, water, and structures must also be considered in radar mapping.

(U) PLANNING

(U) Thorough preflight planning is necessary to reduce the effects of radar system limitation when utilized for navigation and mapping. Analyze the alternatives to and from destination and establish a systematic planning sequence. When the radar check points are not on the route, the off set checkpoints should be plotted in terms of degrees and distance relative to the route, left or right a specific distance; e.g., at 20 miles the check point should be 30° left of the course. Major check points, such as coastal penetration, a prediction scope display should be drawn up; refer to figure 2-28, Radar Prediction Overlay.

(U) The aircrew should, at all times, be prepared for a self-contained emergency radar penetration. By using standard instrument approach procedure, prepare a self-contained radar penetration using a track identical to the normal penetration.

(U) OPERATION AND TECHNIQUES

(U) While radar mapping, the antenna elevation control and the receiver gain control are used constantly to improve the radar presentation. At high altitudes the receiver gain control is the primary control; at low altitudes the antenna position may have the greatest effect. Using the NAV COMP mode in conjunction with radar mapping provides a desirable navigation technique that does not rely on ground positioned navigation aid stations. When the coordinates of a radar check point are placed in the navigation computer, the readout provides a range and azimuth readout that can be used to estimate the location of the check point on the radar scope for subsequent positive identification. The radar can be used to update the navigation computer after a check point is positively identified by setting the check point coordinates in the computer. As the aircraft passes over the check point, present position can be updated. The radar may also be used to obtain a ground speed check and correction for wind drift. For example, when approaching the coastline, a ground speed check may be made and the resultant coastal penetration time compared with the planned time. Speed is then changed to cross coastline on the planned time. When correction is complete, revert to planned speed. Down course check points may be used to compensate for changes in wind direction and speed.

(U) D R NAVIGATION

(U) GENERAL

(U) D R navigation requires detailed analysis of all potential routes, proper map scale selection, and meticulous map preparation and familiarization of the selected route. The following presents the standard map annotation and symbols and a brief definition of each. The procedures and techniques of enroute D R navigation are not presented.

(U) CHART PREPARATION

(U) After the route to and from the target and alternates have been determined, plot the intended flight path on the selected map and annotate with as much information as is useful to mission accomplishment and aircrew inflight orientation.

(U) Enroute Turn Points

(U) When the appropriate IP and turn points for each target are determined and plotted, the enroute turn points should be plotted. The latitude-longitude of each enroute turn point should be noted on the navigation log.

(U) Start Point

(U) The start, or hack, point should be determined and plotted. This is the beginning of the mission and should be far enough from the base to allow inflight checks to be accomplished, but close enough so that fuel is not wasted. The start point should be a prominent terrain feature that cannot be missed or may be the takeoff airfield.

(U) CHECKPOINTS

(U) Locate and note coordinates of good visual checkpoints to determine error and, if necessary, update the navigation computer.

(U) Heading or Track Lines

(U) Once the start point and check points have been determined and plotted, these points must be connected by lines that represent headings or tracks. Distance is determined and depicted for each leg.

RADAR PREDICTION OVERLAY

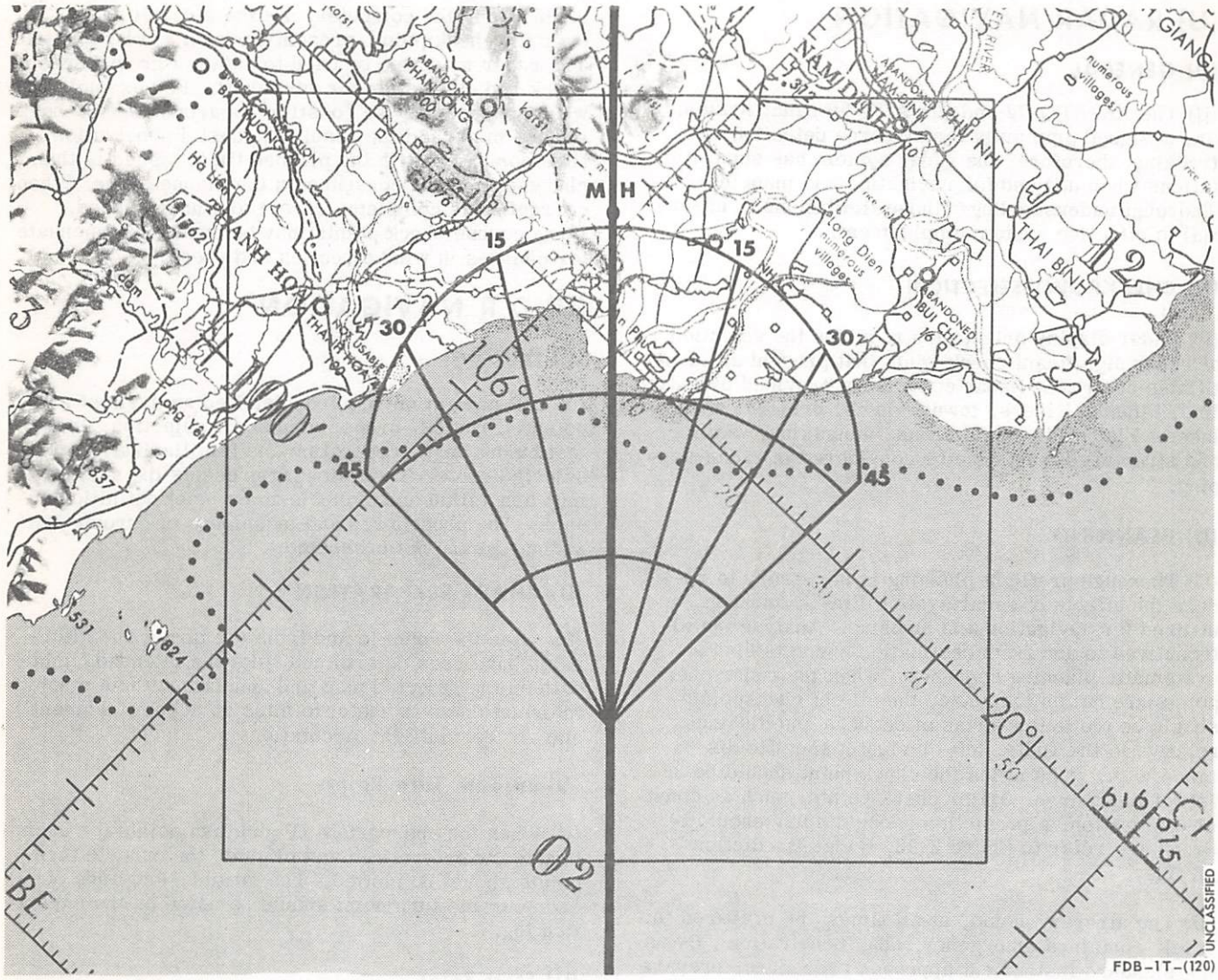


Figure 2-28(U)

(U) Course

(U) The course should be determined using a standard navigation plotter. Both magnetic heading and true ground track should be noted in the FACT (fuel, altitude, course, time) box to the right of the track line.

(U) Distance

(U) Distance is measured from the check or turn point to the start point and depicted as distance-to-go by tick marks on the left edge of the track line. Long, numbered tick marks should indicate odd 10-mile increments and short, unnumbered tick marks should indicate even 10-mile increments.

(U) Time

(U) Tick marks, indicating elapsed time enroute, are placed on the right of the track line. Long, numbered tick marks depict even minutes and small, unnumbered marks indicate odd minutes. Two methods of timing are used: continuous timing and leg timing.

(U) Continuous Timing

(U) When the continuous timing method is used, the stopwatch is started at the start point, or hack point, and is allowed to run continuously throughout the mission. Caution should be used when plotting this timing method. A mistake at the beginning of the mission is evident during the final part of the mission.

(U) Leg Timing

(U) When the leg timing method is used, the stopwatch is restarted at the beginning of each leg. This method provides less chance for error; however, it gives the aircrew an additional task while in the target area.

(U) Altitude

(U) A minimum enroute altitude should be determined for each leg. This information should be noted in the FACT box.

(U) CHART SYMBOLS

(U) Symbols pertaining to the navigation aspects of the mission are shown in blue or black and are normally positioned to the right of the track line. Symbols and annotations pertaining to the operational aspect of the mission are placed to the left of the track line. A plastic template, key, or rubber stamp is used in the actual annotation of the information.

(U) Navigation Symbols

(U) Navigation symbols (figure 2-29) depicting navigational information, such as check points, initial points, course line between check points, and FACT boxes are positioned astride or approximately 2 inches to the right of the course line, as appropriate. When INS coordinates are used, they are portrayed by a one-eight inch cross in the target, IP, and checkpoint symbols.

(U) Target

(U) The target is indicated by a triangle centered on the desired ground zero. The inbound track line from the IP extends into the triangle to the target.

(U) Initial Point

(U) The IP is identified by a square box. Track lines are not drawn through this symbol.

Note

The radar identification point (RIP) when required, is identified by a quarter-inch circle centered on the selected identification point (offset aiming point only).

(U) Check Points

(U) A circle is used to depict enroute points where the magnetic course or true ground track is altered and/or key enroute positions occur. Track lines are not drawn through these symbols.

(U) Air/Sea Rescue Pick-Up Point

(U) This symbol is precisely positioned at predetermined locations where assistance to downed aircrews is planned.

(U) Course Lines

(U) Course lines, or track lines, are drawn for the entire route, inbound to the target and continuing on to portray the return course to the primary recovery base. If a check point is duplicated on a following page, symbols are used to portray direction of entry and departure. In all cases, the IP and target will be located on the same page.

(U) Minute Tick Marks

(U) For low altitude portions of the route, tick marks are placed perpendicular and to the right of the course line, spaced in accordance with planned ground speed. Consecutively numbered ticks one-half inch long indicate distance traveled during a 2 minute interval. They are interspaced by short, unnumbered 1/4-inch ticks portraying 1 minute elapsed time. Tick mark construction from the IP to the target reflects 1-minute numbered ticks. Annotation of the tick marks will be in accordance with the continuous timing or leg timing methods previously discussed.

Note

Where an acceleration point precedes the IP, caution should be taken to compute the time-distance interval for the increased ground speed.

(U) Distance-To-Go Tick Marks

(U) When required, tick marks are placed to the left of the course line at 10-mile intervals between check points. Every other tick mark is 1/4-inch long and numbered. Intermediate tick marks are 1/8-inch long and unnumbered. Distance-to-go will be indicated in descending order between INS destinations.

(U) FACT Box

(U) The FACT (fuel, altitude, course, and time) box is placed approximately 2 inches to the right of all check points and orientated with the course line. Where the next leg of the flight begins on the following page or the navigation leg is split between two pages, the FACT box will be located on both pages. The FACT box is divided into five sections containing the following information, reading from the bottom.

a. Fuel, both required and remaining.
b. Altitude, both minimum and desired.
c. Time, either leg or total.
d. Course, magnetic heading, true ground track, or both.
e. Leg number.

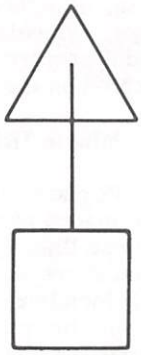
(U) Check Point Information Box

(U) A rectangular box, containing computer information, will be placed approximately 2 inches to the right of check points or desired ground zero symbols when required. This box contains the symbol representing present position (PP) next check point (A), and subsequent check point (B).

NAVIGATION SYMBOLS

TARGET

a. Triangle centered on desired ground zero.
b. Center line indicates course from IP to DGZ.

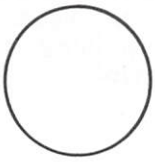


INITIAL POINT (IP)

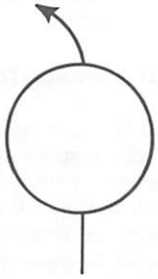
Square centered on initial point.

CHECK POINT

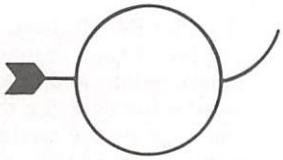
a. Circle centered on geographical check point.



b. When check points are duplicated on the following page, this symbol will indicate departure from that check point.



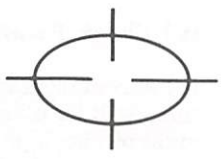
c. The duplicate check point on the following page will show entry direction by this symbol.



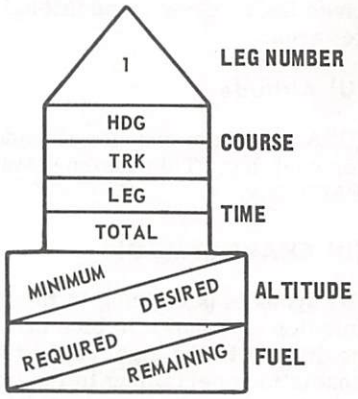
d. Radar identification point (offset aiming point only). A quarter-inch circle centered on the selected identification point.

AIR/SEA RESCUE PICK-UP POINT

Ellipse with spokes. Pick-up point in intersection of spokes.

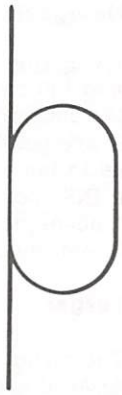


FACT BOX

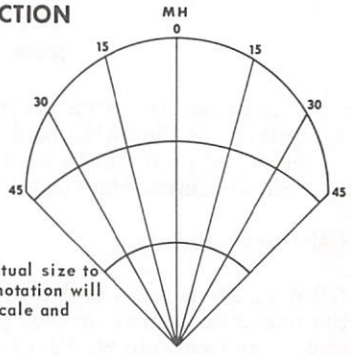


ORBIT POINT

Race track pattern containing orbit point.



RADAR SCOPE PREDICTION



Example shown is not actual size to be annotated. Size of annotation will be determined by chart scale and radar range selected.

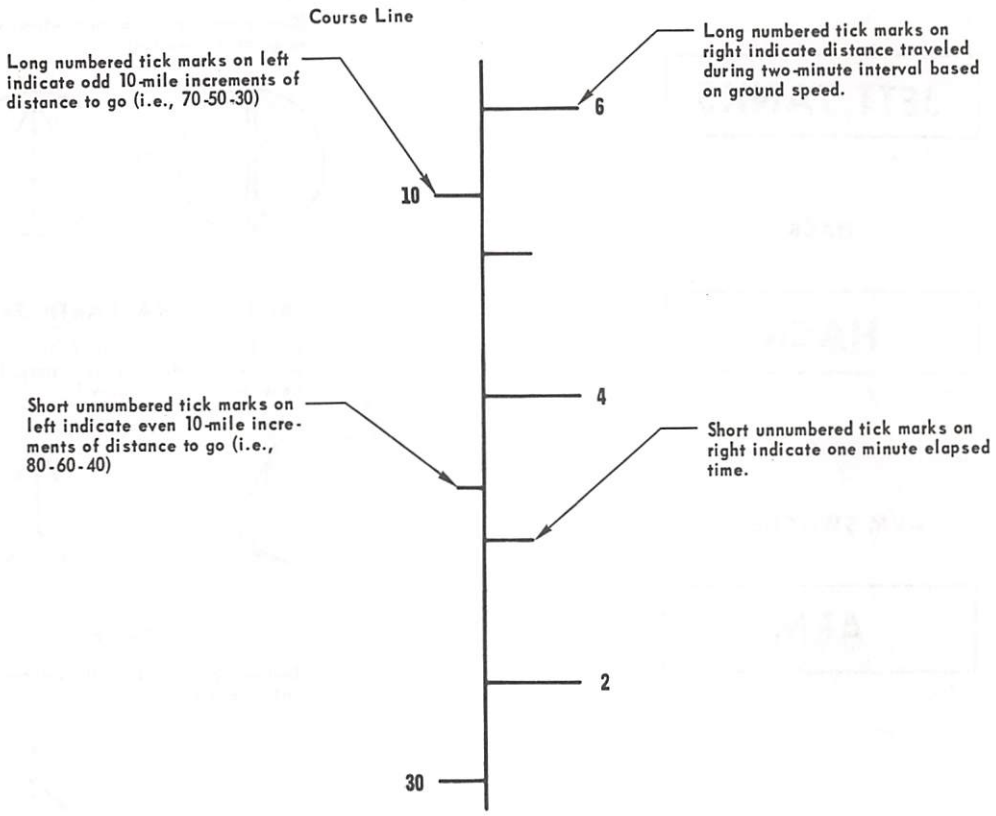
UNCLASSIFIED

FDB-1T-(121-1)

Figure 2-29 (U) (Sheet 1 of 3)

NAVIGATION SYMBOLS-CONTINUED

COURSE AND TICK MARKS



CHECKPOINT INFORMATION BOX

Top section contains coordinates of subsequent check point.

Middle section contains coordinates of next check point.

Bottom section contains present position coordinates.

		LATITUDE–LONGITUDE
SET	B	5016/0250
	A	5052/0310
	PP	5023/0415

UNCLASSIFIED

FDB-1T-(121-2)

Figure 2-29 (U) (Sheet 2 of 3)

NAVIGATION SYMBOLS-CONTINUED

OPERATIONAL ADVISORY ANNOTATIONS

JETTISON TANKS

JETT TANKS

HACK

HACK

ARM SWITCHES

ARM

PULL UP POINT

PUP

ACCELERATION POINT

ACC

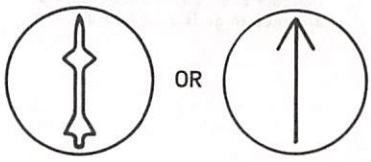
RECOVERY OR DECISION FUEL

#

ENEMY ORDER OF BATTLE ANNOTATIONS

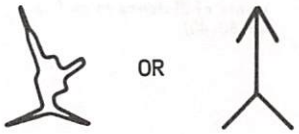
SURFACE-TO-AIR MISSILE

(Circle represents maximum effective range of the missile)



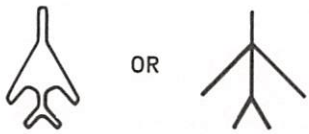
ANTI-AIRCRAFT ARTILLERY

(The letters L/M/H identify the weapons contained in the battery; i.e., light, medium, and heavy.)

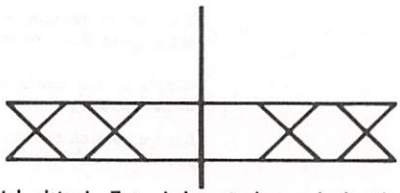


AIRCRAFT

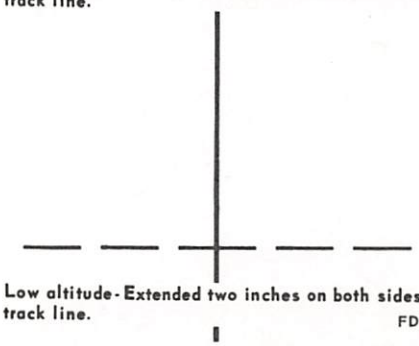
(All-weather aircraft will be annotated with the letter W.)



EARLY WARNING RADAR



High altitude-Extended two inches on both sides of track line.



Low altitude-Extended two inches on both sides of track line.

UNCLASSIFIED

FDB-1T-(121-3)

Figure 2-29 (U) (Sheet 3 of 3)

(U) Radar Scope Prediction Symbol

(U) The exact area of the radar scope prediction will be outlined on the map in the shape of the appropriate radar display.

(U) Operation Advisory Annotations

(U) Operational advisory annotations (figure 2-29) concerning the operational aspects of the mission will be positioned at least 2 inches to the left of the course line at the point enroute where the function should be performed. Annotations will be contained in a rectangular box.

(U) Tank Jettison Point

(U) A reminder to jettison external tanks is placed adjacent to the planned position when operationally required.

(U) HACK Point

(U) A reminder to reset the stop clock will be indicated by HACK points where required.

(U) Arm

(U) Set all switches as they should be in the target area.

(U) Pull-Up Point

(U) The pull-up point reminder (PUP) will be placed at the points enroute where a pull-up to increase altitude is required.

(U) Acceleration Point

(U) The notation ACC is a reminder at the point enroute where airspeed is increased to meet operational requirements.

(U) Remaining Fuel Requirements

(U) The fuel to successfully complete the remainder of the mission will be indicated at appropriate points along the route. BINGO fuel requirement will be annotated indicating fuel required to recover at the selected primary recovery base.

(U) Enemy Order of Battle Annotations

(U) Enemy order of battle symbols (figure 2-29) will be annotated in red and positioned at the location of the enemy defensive threat.

PART 2 MISSIONS

(U) The tactical considerations presented in this section should be used for refresher/orientation, and does not intend to cover all aspects of each situation that may be encountered. The general considerations listed will aid the aircrew in mission planning. Refer to the Secret Supplement to this manual for maneuvering in a defended area, ECM considerations, etc. Even though portions of part 2 are applicable to both F-4B/N and F-4J aircraft, only the F-4B/N aircraft is presently considered.

MISSION PLANNING INDEX

(U) MISSION PLANNING CONSIDERATIONS

(U) This mission planning index (figure 2-30) identifies and provides a reference to the information available in this manual. The items listed are not applicable to all missions, targets, or delivery maneuvers. This list should be used only as an index. Each squadron should prepare its own planning/briefing guide according to its primary assignment and the specific fuzes and ordnance that they are actually using.

(U) Mission planning includes consideration of the target conditions, mission objective, enemy defenses, ordnance and fuzes available, aircraft load configuration, aircraft limitations, enroute navigation, delivery maneuver, weapon limitations, fragment envelope or terrain avoidance limitation, bomb release or rocket launch conditions, escape maneuver and re-attack or return (divert) or alternate target.

PREPLANNED STRIKES

(U) The primary mission of the preplanned strike is the destruction of specific targets at known locations. Previous considerations will have included such factors as target definition, enemy as well as friendly order of battle, number and type of aircraft in the strike group, available ordnance, fire support plan, and weather enroute to and at the target. When necessary, F-4 tactics may be compromised to provide optimum employment of the strike group.

(U) Enroute tactical considerations should include:

a. Profile.

(1) High (above 20,000 feet) provides flexibility of delivery maneuvers, increases fuel economy, and reduces AAA effectiveness.
(2) Intermediate (1,000 to 20,000 feet) provides increased maneuverability to counter enemy air and SAM threats (if SAM threat exists, refer to secret supplement).
(3) Low (below 200 feet) provides radar masking.

b. Airspeed.

c. Maneuvering.

(U) A continuous change in altitude and heading (jinking) is recommended to counter visual and/or radar tracking. Rapid changes in aircraft attitude do not constitute effective jinking. If SAM threat exists, refer to the secret supplement.

(U) Tactical consideration at the target should include:

a. Individual attack (one element).

(1) Delivery maneuver (refer to section II, part 3).
(2) Attack heading should, whenever possible, take advantage of terrain, sun, wind, and enemy defenses as well as target alingment (greatest errors are in range).
(3) Retirement should take advantage of the location of safe areas as well as target defenses.

b. Coordinated attacks (more than one element).

(1) Timing (refer to section II, part 3).
(2) Attack heading for each element should be varied to split the enemy defenses.
(3) Aim points should be specified for each element when attacking an area target. Normal bomb dispersion will not adequately cover an area target when a central arm point is used.
(4) Retirement is the same as for individual attacks except post strike rendezvous must be considered.

c. Supporting Elements.

(1) Flak suppression is designed to prevent enemy AAA from firing at the strike group. It is intended to free the strike group for complete concentration on the target and delivery maneuver. Timeliness of flak suppression and ECM is of utmost importance.
(2) ECM (refer to the secret supplement).

MISSION PLANNING INDEX

REFERENCE – PAGE NO.

I. TARGET DESCRIPTION AND WEATHER

1. Description, Mission Objective, Weapon Selection and Pre-Attack Considerations _____ — 2-1, 2-36, 2-120
2. Location: _____ lat _____ long _____ — (Use Target maps and Forecaster)
3. Elevation (MSL) _____ feet
4. Enroute Heading _____ deg Mag.
5. Distance to Target _____ nautical miles
6. Altimeter setting over target _____ In Hg
7. Pressure Altitude _____ feet.
8. Temperature _____ °C
9. Wind: _____ deg, _____ kts, _____ ft
   _____ deg, _____ kts, _____ ft
10. Cloud Cover: _____ %, _____ ft
    _____ %, _____ ft

II. LOAD CONFIGURATION

1. Airplane serial number _____ .
2. Load Configuration: (also VIII Preflight Conditions) — NATOPS.)

Station	Item	Weight	Stab No.	Drag
1, 9				
2, 8				
5				
3, 4, 6, 7				
Totals				

3. Airplane operating weight _____ lbs — NATOPS
4. Internal fuel (less unusable fuel) _____ lbs — NATOPS
5. Take off gross weight _____ pounds
   (Add Items 2, 3, & 4)

UNCLASSIFIED

FDB-1T-(122-1)

Figure 2-30 (U) (Sheet 1 of 8)

MISSION PLANNING INDEX-CONTINUED

II. LOAD CONFIGURATION – Continued	REFERENCE – PAGE NO.
6. CG location (use Weight and Balance Manual AN 01-1B 40):	NATOPS
a. Aft per missible CG limit _____ % MAC	
b. Aircraft CG at takeoff _____ % MAC	
III. NAVIGATION	
1. Radar/DR navigation and chart preparation.	2-79, 2-86, 2-120 (Use Target maps and Forecaster).
2. Base:	
a. Pressure altitude _____ ft	
b. Temperature (surface) _____ °C.	
c. Surface wind _____ deg at _____ kts.	
d. Target located _____ NM from Base on _____ °True	
3. Divert Field:	
a. Pressure altitude _____ ft	
b. Temperature (surface) _____ °C	
c. Surface wind _____ deg at _____ kts.	
d. Location _____ NM from Base on _____ °True	
4. Enroute Conditions:	
a. Cruise In: alt _____ ft; wind _____ deg at _____ kts	
b. Return Cruise: alt _____ ft; wind _____ deg at _____ kts	
c. Max Cruise In speed _____ KCAS, _____ Mach	
d. Aircraft gross weight over target _____ lbs.	
e. Landing reserve fuel _____ lbs.	

UNCLASSIFIED

FDB-1T-(122-2)

Figure 2-30 (U) (Sheet 2 of 8)

MISSION PLANNING INDEX-CONTINUED

	REFERENCE – PAGE NO.
IV. MISSION (PART 2)	
1. Pre-planned Strikes	2-86.
2. Armed Reconnaissance	2-95.
3. Close Air Support	2-96.
4. Special Missions	2-101.
a. Helicopter Escort	2-101.
b. TPQ-10 Ground Controlled Radar Bombing	2-102.
c. Night Attack	2-104.
d. Laser Guided bomb	2-115.
V. DELIVERY MANEUVERS (PART 3)	
1. Bombing/Rocketry	2-124, 2-136.
a. Crew Coordination	2-124.
b. Firebomb Delivery	2-136.
2. Strafing	2-138.
3. Dive Delivery Considerations	2-125.
4. Level Delivery Considerations	2-133.
5. Multiple Release Considerations	2-135.
6. Safe Escape Considerations	2-120.
7. CONLABS Delivery	2-142.
VI. LIMITATIONS	
Fuze, weapon, airplane, target, launch, and recovery limitations/ restrictions.	2-37, 2-120.
1. Fuze _____	(Fuze Data Index 2-1 for applicable fuze)
a. Bomb/Fuze Combinations table, check.	2-38 (For Rockets, 2-70).
b. Minimum Authorized Arming Times and Speeds _____ sec	2-45.
c. Arming delay tolerance _____ to _____ sec	
d. Arming delay setting _____ sec	
(Arming delay must be equal to or greater than Item 1b. The last bomb time-of-fall must be greater than Item 1c plus Item 1d.	

UNCLASSIFIED

FDB-1T-(122-3)

Figure 2-30 (U) (Sheet 3 of 8)

MISSION PLANNING INDEX-CONTINUED

VI. LIMITATIONS – Continued	REFERENCE – PAGE NO.
e. Functioning Delay setting _____ sec	(Fuze Data Index 2-1 applicable fuze)
f. Carriage speed, max _____ KCAS	
g. Delivery speed, max _____ KCAS	
, min _____ KCAS	
h. Release altitude minimum _____ ft	
i. Impact angle requirement _____ deg	
j. AWW-1/4 Option Selector setting _____	
2. External Store Limitations	(Appendix A for applicable Weapon)
a. Load Code _____	
b. Aircraft sta 1; MER/TER sta (1)(2)(3)(4)(5)(6)	
2; TER sta (1)(2)(3)	
5; MER/TER (1)(2)(3)(4)(5)(6)	
8; TER sta (1)(2)(3)	
9; MER/TER sta (1)(2)(3)(4)(5)(6)	
(Check hooks open or closed)	2-3, 2-29, 2-45.
c. Carriage: _____ KCAS, _____ M, _____ Sym G., _____ Un Sym G	
d. Release: _____ KCAS, _____ M, _____ G	
e. Jettison: _____ KCAS, _____ M, _____ 1 G Level flight	
f. Max dive angle _____ deg	
g. Wpn sel knob: (RKT DISP) (BOMBS; SINGLE, PAIRS, RIPPLE, CLUSTER)	
h. Interval selector switch position (.06)(.10)(.14)	
i. Other weapon limitations _____	

UNCLASSIFIED

FDB-1T-(122-4)

Figure 2-30 (U) (Sheet 4 of 8)

MISSION PLANNING INDEX-CONTINUED

VII. DELIVERY CONDITIONS	REFERENCE – PAGE NO.
1. Dive Angle (or level) _____ deg	(For Airspeed Conversions 2- 161).
2. Release airspeed _____ KCAS, _____ KTAS	
3. Safe Escape:	
a. Top of frag envelope _____ ft	2-120, Pocket Guide.
b. Minimum interval between aircraft _____ sec	2-120
c. Minimum release and recovery height for 4.0G pullout	(Sight Angle Charts, Index 2-1 for applicable weapon.)
(1) For terrain avoidance; Rel _____ ft, Recovery _____ ft	
(2) For 0.000 frag risk; _____ ft, Recovery _____ ft	2-45.
(3) For 0.001 frag risk; _____ ft, Recovery _____ ft	
(4) For 0.010 frag risk; _____ ft, Recovery _____ ft	
4. Release Height of last bomb (AGL) _____ ft	
5. Number of bombs released per run _____	
6. Altitude lost during ripple release _____ ft	2-174.
7. Release height of first bomb (AGL) _____ ft (Add: Items 4 + 7)	
8. Altimeter lag: SPC ON _____ ft; SPC OFF _____ ft (Also pilot reaction time)	2-165.
9. Indicated Rel Hgt (AGL): SPC ON ____ ft; SPC OFF _____ ft (Add: Items 7 + 8 + Target Elev.)	
10. Aircraft alt lost (_____ G pullout) _____ ft	2-167.
11. Recovery height (AGL) _____ ft (Subtract: Item 10 minus 4)	

UNCLASSIFIED

FDB-1T-(122-5)

Figure 2-30 (U) (Sheet 5 of 8)

MISSION PLANNING INDEX-CONTINUED

VII. DELIVERY CONDITIONS – Continued	REFERENCE – PAGE NO.
12. Stick length _____ ft (Bomb Spacing ____ ft)	Bomb spacing charts
13. Last bomb time-of-fall (TF) _____ sec	Sight angle chart
14. Sight angle (middle bomb on target) or (first bomb on target) for 42,000 lbs gross weight, released from _____ feet AGL: _____ mils	(Sight angle chart or Pocket Guide)
15. Sight angle correction for gross weight _____ mils	2-166.
16. Wind Correction _____ ft/10 knots wind. (Multiply Item 13 by the number 17)	
17. Entry Position and Tracking:	2-125.
a. Entry height _____ ft AGL	2-170.
b. Entry power setting _____	2-170.
c. Entry airspeed _____ KTAS	2-170.
d. Pop-up distance from target _____ ft	2-173.
18. Approx time from rollin to last bomb off:	
a. Entry height minus last bomb release height _____ ft	
b. Slant range from entry to last bomb release _____ ft	2-173.
c. Average speed entry to release ____ KTAS, ____ fps (Knots times 1.7 = fps)	
d. Time from entry to last bomb _____ sec (b/c)	
19. Pilot/R10 Commentary	2-124.
20. Firebomb Delivery	2-136.
21. Rocketry	2-136.
22. CONLABS Delivery	2-142.
a. Sample problem	2-154.
b. Delivery data	2-150.

UNCLASSIFIED

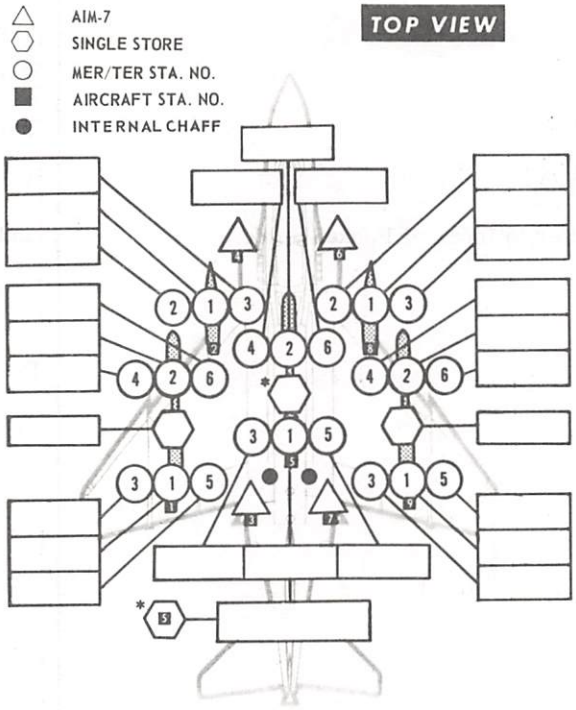
FDB-1T-(122-6)

Figure 2-30 (U) (Sheet 6 of 8)

MISSION PLANNING INDEX-CONTINUED

VIII PREFLIGHT CONDITIONS	REFERENCE – PAGE NO.
1. Optical Sight check.	2-145.
a. Tagged boresight value defined.	2-145.
2. Weapon preflight checks. Use Pocket Guide applicable Stores Reliability Card; NAVAIR number is given in the weapon description.	Pocket Guide
3. Fuze preflight check: Refer to fuze description.	Index 2-1.
4. Suspension Equipment safety pin location	2-29.
5. Check load configuration, hooks open or closed, centerline cable modification	

LOAD CONFIGURATION



1. Check hooks open or closed
2. Check MER shifted forward of aft
3. Check for centerline mod to double the release interval, (yes) (no)

UNCLASSIFIED

FDB-1T-(122-7)

Figure 2-30 (U) (Sheet 7 of 8)

MISSION PLANNING INDEX-CONTINUED

IX INFLIGHT CONDITIONS	REFERENCE – PAGE NO.
1. Switchology. Refer to index of Pocket Guide:	
a. Armament bus circuit breakers	2-1.
(1) Armament safety override button	
b. Multiple weapons system	2-1.
(1) Fuze function Control Set	
c. Gunnery Equipment	2-15.
d. CONLABS Release System	2-18.
e. Jettison System	
f. Suspension Equipment	2-23.
	2-29.
2. Inflight fuzing options:	
a. MK 344/376 Tail Fuze	2-55.
b. MK 339 Mod O Fuze	2-62.
c. M 20/20 A1 Sensing Element	2-64.
d. MK 43 Target Detecting Device	2-67.
3. Release error sensitivities. Refer to index of Pocket Guide.	Index 2-1.
4. Inflight Planning Index.	Pocket Guide.
5. Using the pocket Guide	Pocket Guide.

UNCLASSIFIED

FDB-1T-(122-8)

Figure 2-30 (U) (Sheet 8 of 8)

ARMED RECONNAISSANCE

(U) TYPICAL ARMED RECONNAISSANCE TACTICS

(C) Armed reconnaissance is a specific type of deep air support mission. Specifically, it may be defined as a planned air mission flown with the primary purpose of searching out, attacking, and destroying targets of opportunity along a designated line of communication (LOC) or within an assigned area. It is not for the primary purpose of attacking specified briefed targets. Armed reconnaissance is used primarily to:

a. Deny the enemy the use of LOC's by preventing movement along the roads, railroads, or waterways, through destruction of vehicles, locomotives, shipping, and all types of mobile equipment.
b. Prevent enemy build-up of troop or supply concentrations in a general area.
c. Collect the following information: direction of movement of forces and weapons into or within the battle area; location and defensive arrangement of enemy weapons; disposition of enemy ground forces; concentration and build-up of strategic reserves; total apparent strength; conditions of lines of communication and their capacity. With this information, ground and air commanders are in a better position to predict probable enemy courses of action.

(C) Armed reconnaissance normally will be accomplished in flights of two or four aircraft, due to the constant maneuvering required in this type mission. If air supremacy has not been attained, it may be necessary to employ one section as top cover. In this case, one section would cover the route at the prescribed lower altitude while the second section would position itself to provide maximum defensive look-out capability against enemy aircraft. Enough offensive fire-power should be retained by each section for defense against possible enemy air action during egress.

(C) Weapons loads on reconnaissance missions are normally restricted to those types of ordnance which provide the greatest accuracy without sacrificing flexibility. Typical ordnance consists of rockets, guns, and CBU's.

(C) Airspeed during armed reconnaissance missions will vary, depending on enemy ground defenses. If enemy ground defenses are present, flight planning should be based on military power fuel consumption and an airspeed of 400-500 KCAS. In planning for armed reconnaissance missions, estimate the total time that will be spent in the assigned area and establish a BINGO for the most distant point. If an extended LOC is to be observed, a good rule of thumb is to multiply the length of the LOC by a factor of 1.3 to allow for flight maneuvering over the intended route. Sufficient fuel must be kept in reserve to make scheduled recovery times.

(U) FLIGHT TACTICS

(C) Flight tactics and formation positions should be determined by anticipated enemy air action, size of flight, intensity of enemy ground fire and type of terrain to be reconnoitered. Formations generally involve constant scissoring about the route being reconnoitered, especially if enemy ground defenses are present. Keep in mind that both sections will be varying altitude and jinking along the route.

(C) Wingman will be abeam about 3000 to 5000 feet of lateral separation as dictated by the type of terrain. The in-trail position should be avoided as much as possible, especially when in areas where enemy ground fire is suspected. Depending on visibility, the second section will fly approximately 1 to 2 miles behind and above. This section will serve primarily as a defensive look-out for the lead section and secondarily as an attack section.

(C) As the flight progresses, the lead section will constantly change heading, altitude, and airspeed. In this manner, the section will "half lazy-eight" back and forth across the route of intended reconnaissance. The capability and expected intensity of enemy defense systems will determine the basic reconnaissance altitudes. Generally, the leader's altitude should be between 1500 to 3000 feet AGL in undefended areas, 4000 to 6000 feet AGL when enemy ground fire is encountered, and in known defended areas. In an enemy SAM environment, aircrews must continuously monitor their DECM equipment and, if required, initiate the necessary evasive maneuvers. The second section will follow at the prescribed interval.

(C) Wingmen should fly a position cone to the rear of the leader. To provide lateral separation among the flight members, they should strive to position themselves to the outside on each turn. The leader's wingman should act as a second pair of eyes in spotting and identifying targets. The second section wingman should support the section leader in his defensive lookout role. Wingmen will constantly maneuver in a modified fighting wing position. The offensive formation just described accomplishes the following:

a. Places the section in a maneuverable position and provides added defensive lookout capability.
b. Permits the section to make a follow-up attack on a multiple target or a target spotted by the leader, but which the leader is unable to immediately attack.
c. Complicates the enemy defensive fire control problem by the constant changing of heading, altitude and airspeed.
d. Permits search scanning of a wide area on both sides of the intended line of coverage.
e. Places the section in a position to accomplish their task, while being ready to back up an attack if necessary.

(C)
f. Varies the look angle of observation from the vertical to level angles. This requires the enemy to camouflage equipment completely on all sides as well as the top.
g. Allows each section to provide mutual support for the other in the event of enemy air attack.

(U) ATTACK TACTICS

(C) When a target is spotted and called out by either section, the flight leader will direct the aircraft in the most advantageous position to attack. Ideally, the second section will strive to be in a position to launch an immediate attack on targets sighted by the lead section. When the enemy sights the flight, they will attempt to disperse and hide their troops, trucks, etc. Therefore, it is extremely important that the flight initiate an attack as soon as possible when a target is sighted.

(C) Against any type target, only the ordnance necessary to achieve the desired degree of destruction should be expended. Rather than expend most of his ordnance in a quick and dispersed attack, the section leader should strive for pin-point accuracy against a single target. The wingman should expend part of his weapons on a follow-up attack if destruction was not previously accomplished. An attack by the wingman may also be necessary if a group of targets is spotted. Each flight member, by attacking a single target, should effectively destroy more targets rather than have a smattering of minor damage to many targets. In all instances, the wingman must insure that the leader is clear before releasing or firing munitions.

(C) Armed reconnaissance goes hand-in-hand with the various random tactics. Generally, altitudes will be compatible with low level or medium altitude attacks. The second section should maintain a position that will permit an immediate attack against targets detected but overflown by the first section. It will normally be necessary for the first section to reverse course to deliver weapons on targets that are detected late or overflown. Always be alert for possible enemy defenses within the area.

(C) Pilots will not always be able to achieve their pre-planned release conditions. Therefore, a high degree of skill in weapons delivery is mandatory. He must be capable of continually analyzing the delivery maneuver and be highly proficient in weapons delivery with varying release conditions. This skill can be gained only through practical experience. Being able to deliver ordnance from any position relative to the target will permit the effective delivery of weapons on the first attempt and increase the chances of survival against heavily defended targets. Remember, the enemy will probably increase defenses along critical or frequently observed routes.

(C) Techniques of enemy camouflage will vary according to tactical need and cleverness. Pilots must assume that the enemy is concealed in the assigned area. The absence of vehicles or trains along a route does not clearly indicate that the routes are not being used. Diligent searching along the routes may be extremely rewarding. If intensive enemy fire is encountered during flight or during an attack, it can be assumed that he is defending something of importance. If heavy fire is encountered, extreme vigilance should be exercised in attempting to determine the location of the defended target since you have lost the advantage of surprise. Be aware of possible flak "traps" such as isolated vehicles parked along or on a road. Evasive action or jinking should be employed to reduce the probability of damage by ground fire.

CLOSE AIR SUPPORT

(U) Close Air Support provides a supporting arm to the ground commander in addition to the artillery and Naval gunfire. Employment of the supporting arms involves detailed coordination of planned and current maneuvers of friendly ground units. Ground Commanders utilize the Fire Support Coordination Center (FSCC) to coordinate all their supporting fires. Represented in the FSCC is an Air Liaison Officer (ALO) to advise the ground Commander on the employment of Close Air Support and to coordinate with the other supporting arms. When an aircraft receives clearance on the target, the communication and coordination has been done to facilitate a successful employment of the air arm.

(U) COMMAND AND CONTROL

(U) Command and control is designed to effectively utilize and control all available supporting air forces before, during, and immediately after an amphibious assault in order to provide the continuous fire support required. In an amphibious operation, the COMMANDER AMPHIBIOUS TASK FORCE (CATF) is responsible for providing and coordinating the offensive and defensive air support in the objective area. The TACTICAL AIR CONTROL CENTER (TACC) afloat is the primary control agency which coordinates and controls all phases of active counter-air-warfare and air support for an amphibious operation. The TACC coordinates and controls all aircraft entering or passing through the objective area. During the amphibious operation, certain Marine air control facilities are moved ashore (TACP, DASC, TAOC, TADC). Once the Landing Force Commander (LFC) has air control facilities established and functioning, the CATF passes control ashore. With the control agencies ashore, the TACC or TADC controls all aircraft entering or passing through the objective area.

(U) All requests for close air support are sent to the DASC (CONTROL ASHORE) or the SACC (CONTROL AFLOAT) with each echelon of command monitoring through the FSCC with silence to mean approval.

Figure 2-31 is the form used to request Close Air Support and figure 2-32 is the form used by a control agency to brief crews prior to entering the objective area. These forms have all the required and detailed information for the general case; however, locally produced condensed forms are often used in situations where current general procedures are known to the aircrews.

(U) Types of requests being used are *on-call* and *preplanned* . An on-call request is one made as the ground action dictates. A preplanned request is made as operational planning is undertaken for future operations. Close air support aircraft will check in with the appropriate control agencies enroute to the target area as briefed. See figure 2-33. A check-in with a controlling agency will usually include the following information:

a. Call sign of the flight
b. Number and type of aircraft
c. Number and type of ordnance
d. Time on station
(Maximum amount of time to stay on station and still be able to locate target and deliver the ordnance)

(U) TYPES OF ATTACK

(U) To avoid injury to friendly ground forces and to provide maximum support, accuracy is the primary concern for close air support. Minimum slant range deliveries reduce error sensitivities and provide best accuracy. Generally, attack headings will be parallel to friendly lines in order to expose the friendly position to deflection error rather than range error which is normally much larger. Care must be exercised in determining and compensating for wind effects. Additionally, although not normally the overriding factor, the aircrew should be aware of the increased vulnerability of their aircraft to ground fire when delivering at low altitudes. Comments on various types of ordnance follow:

(U) 20mm STRAFING

(U) Strafing provides the most accurate means of supporting ground forces. Due to this increased accuracy, strafing can be employed very close to friendly ground units.

NEW NEW NEW NEW

(U) The nose gun attitude relative to the fuselage reference line (FRL) can be optimized for the type mission: air-to-air or air-to-ground. For air-to-ground, pendulum effect is reduced and an additional 35 mils sight depression is obtained when the gun barrel attitude (gun bore line) is parallel to FRL. For air-to-air gunnery, the gun barrel attitude should be parallel to the missile launcher line and radar boresight line which is 2° below FRL. With the gun barrel line 2° below FRL, the pilot is relieved of changing the sight setting when switching from missiles to guns. The attitude of the gun should be marked on the Tagged Boresight Value placard. Sight angle charts are available for both gun attitudes.

(U) BOMBS

(C) Normally, minimum slant range, level or low angle retarded Snakeye or napalm deliveries are preferable for accurate support. However, Rockeye II deliveries at minimum altitude can produce acceptable bomblet deflection dispersions (normally less than 200 feet). CBU-24 type munitions, on the other hand, have pattern widths (800 feet and greater) which require large stand off distances from the friendly position. Free-fall bombs should be delivered in low or medium angle attacks at minimum authorized altitude. Care must be exercised not to dud ordnance by pressing the target to less than the required range for fuze arming. This is particularly important in the free-fall bomb case.

(U) ROCKETS

(U) The use of rockets in close air support should be at minimum slant range. Ballistic dispersion is a serious consideration when operating in the vicinity of friendly ground forces; however, rocket dispersion can be minimized by close in deliveries. Recent testing has shown that (unlike the free-fall bomb case) there is virtually no accuracy improvement to be gained by repeated (successive) runs. Therefore, unless multiple target assignments or suppressive fire is indicated, it is tactically desirable to maximize fire on one run (i.e. ripple fire as many pods as possible).

(U) CONDUCT OF THE ATTACK

(U) The following provides a normal guideline for the aircrew. Modifications to these procedures may be made by the local operating commander. After receiving clearance into the target area from the controlling agency, the crews of close air support aircraft will:

a. Visually acquire the TAC(A), FAC(A) or the FAC and the target. Each pilot in the flight will acknowledge a visual contact with the controller and target before releasing ordnance. The offset trail formation is normally used once the aircraft are cleared into the target area for visual identification. This formation allows flight crews the maximum lookout doctrine for the controller, target, terrain avoidance, other aircraft, and enemy ground fire.

b. Maintain two way communication between attacking aircraft and the controller. Squadron standing operating procedures will establish procedures for aircraft without a transmitter or receiver. Normally, close air support aircraft will be required to have both a transmitter and receiver when dropping in close proximity to ground troops. Depending on the ground action, this requirement may be altered.

c. Maintain assigned attack heading or run-in heading and pull off direction as assigned by the controller. The attack heading and pull off direction assigned may not be the most desirable due to sun position, terrain, position of target, and enemy ground fire which may dictate a change. A change in attack heading or pull off direction may be requested by the pilot and will usually be approved provided the new attack heading does not endanger the ground troops. The pilot may desire different attack headings on each run depending on the enemy situation. In addition to a heading change, the pilot will normally jink prior to the attack and pull out.

d. Maintain approximately 30 second intervals between attacking aircraft for proper spacing to avoid

TACTICAL AIR REQUEST FORM

TACTICAL AIR REQUEST MISSION NO. _____

ORIG. CALL

1. (TADC/DASC) THIS IS (TACP)
2. I HAVE ☐EMERGENCY ☐PRIORITY ☐ORDINARY ☐SEARCH ATTACK ☐MISSION

MISSION REQUEST — SENT

1. TARGET IS ☐AAA POSIT ☐MORTAR POSIT ☐SUPPLIES ☐TROOPS ☐ ☐GUN POSIT ☐PILL BOX ☐TANKS ☐VEHICLES ☐
2. IN (T.A.) CHART (NO.)
3. TARGET BEARS yd./meters TRUE FROM (Landmark) DISTANCE
4. ☐STATIONARY ☐MOVING (Give Direction) ON/THRU — REC'D
5. ☐WILL ☐WILL NOT MARK WITH SMOKE
6. REQUEST ☐BOMBING ☐STRAFING ☐ROCKET ☐NAPALM ☐ ATTACK
7. HEADING (Mag.) PULL OUT ☐RIGHT ☐LEFT ☐STRAIGHT MINIMUM ALTITUDE
8. REQUEST (# Runs) USING (# Armament) PER RUN — TIME
9. RUN MISSION ☐ASAP ☐AT (Time) ☐AFTER ☐BEFORE BETWEEN (Time) AND (Time)
10. FRONT LINES FROM (T.A.) TO (T.A.)
    ☐MARKED ☐NOT MARKED WITH (Color) ☐PANELS ☐SMOKE — BY
11. ☐FRONT LINE ☐FAC IS (GIVE DISTANCE AND DIRECTION) FROM TARGET
12. ☐I CAN OBSERVE ☐I WILL CONTROL ☐TARGET HIDDEN ☐USE OTHER CONTROL
13. REMARKS

ARTY NGF

ARTY INFO (Initials) — ACI/AIO — TARGET LOCATION CHECKED (Initials) — APPROVED SAC/FSC
NGF INFO (Initials) — FRONT LINES CHECKED — TIME — BY

MISSION APPROVAL AND BRIEFING MESSAGE

1. (TACP) THIS IS (TADC/DASC) — SENT
2. MISSION (No.) ☐APPROVED ☐CANCELLED ☐TADC ☐DASC ☐TACP ☐TACA ☐FLT LEADER WILL CONTROL
3. CONTACT (TACA, Flt Leader) WITH (No.) ☐VF ☐VA (Load) NET (No.) — REC'D
4. RESTRICTIVE FIRE PLAN IN EFFECT FROM (Time) TO (Time)
5. REMARKS — BY

DAMAGE ASSESSMENT AND AMMO. EXPENDITURE

1. (TADC/DASC) THIS IS (TACP/TACA/Flt Leader) — SENT
2. TARGET ☐NOT ☐COMPLETELY ☐PARTIALLY ☐DESTROYED ☐NEUTRALIZED ☐COVERED
3. REMARKS — REC'D

	NO.	TYPE		NO.	TYPE
BOMBS			NAPALM		
AMMUNITION			MISC.		
ROCKETS					

4. — TIME
5. ACI/AIO COMMENTS — BY

UNCLASSIFIED

FDB-1T-(123)

Figure 2-31 (U)

PILOT BRIEFING FORM

PILOTS' BRIEFING FORM Mission No. _____ Time _____

_____ THIS IS _____
(FLT LDR, TAC(A)) (DASC, TAC(A), TACP, TACC)

TYPE MISSION: Emergency Priority, Ordinary, Search/Attack

1. TARGET ☐ AAA Posit ☐ Mortar Posit ☐ Supplies ☐ Gun Posit ☐ Pillbox ☐ Tanks ☐ Troops ☐ Vehicles _____

2. TARGET AREA _____ CHART NO. _____

3. TARGET BEARS _____ (DIRECTION), _____ (DISTANCE) Yards-Meters, FROM _____ (LANDMARK)

4. TARGET IS Stationary, Moving _____ (DIRECTION) On Thru _____

5. Will, Will Not MARK WITH _____ (COLOR) SMOKE

6. TYPE ATTACK Bomb Strafe Rocket Napalm _____

7. HEADING (MAG) _____ PULL OUT Right, Left, Straight MINIMUM ALT _____

8. MAKE _____ (NO. RUNS) USING _____ (ARMAMENT) Per Run

9. RUN MISSION Asap, At, After, Before _____ (TIME)

Between _____ (TIME) and _____ (TIME)

10. FRONT LINES POSIT FROM _____ (T.A.) TO _____ (T.A.)

MARKED, Not MARKED with _____ (COLOR) Panels, Smoke

11. Front Line, FAC, IS _____ (DISTANCE), _____ (DIRECTION) FROM TARGET

12. _____ (TACC, DASC, FLT LDR, TAC(A), TACP) WILL CONTROL

13. USE _____ (NO.) VF, VA, ON _____ (COMM. NET)

14. RESTRICTIVE FIRE PLAN IS _____, IS NOT _____ IN EFFECT FROM _____ (TIME) TO _____ (TIME)

FROM (COORD) _____ TO (COORD) _____

WIDTH (YD/METERS) _____ MIN ALT _____ MAX ALT _____

15. ADDITIONAL REMARKS:

_____

DAMAGE ASSESSMENT AND AMMO EXPENDITURE

_____

1. TARGET DAMAGE _____ ORDNANCE EXPENDED _____

2. ADDITIONAL REMARKS _____

UNCLASSIFIED

FDB-1T-(124)

Figure 2-32 (U)

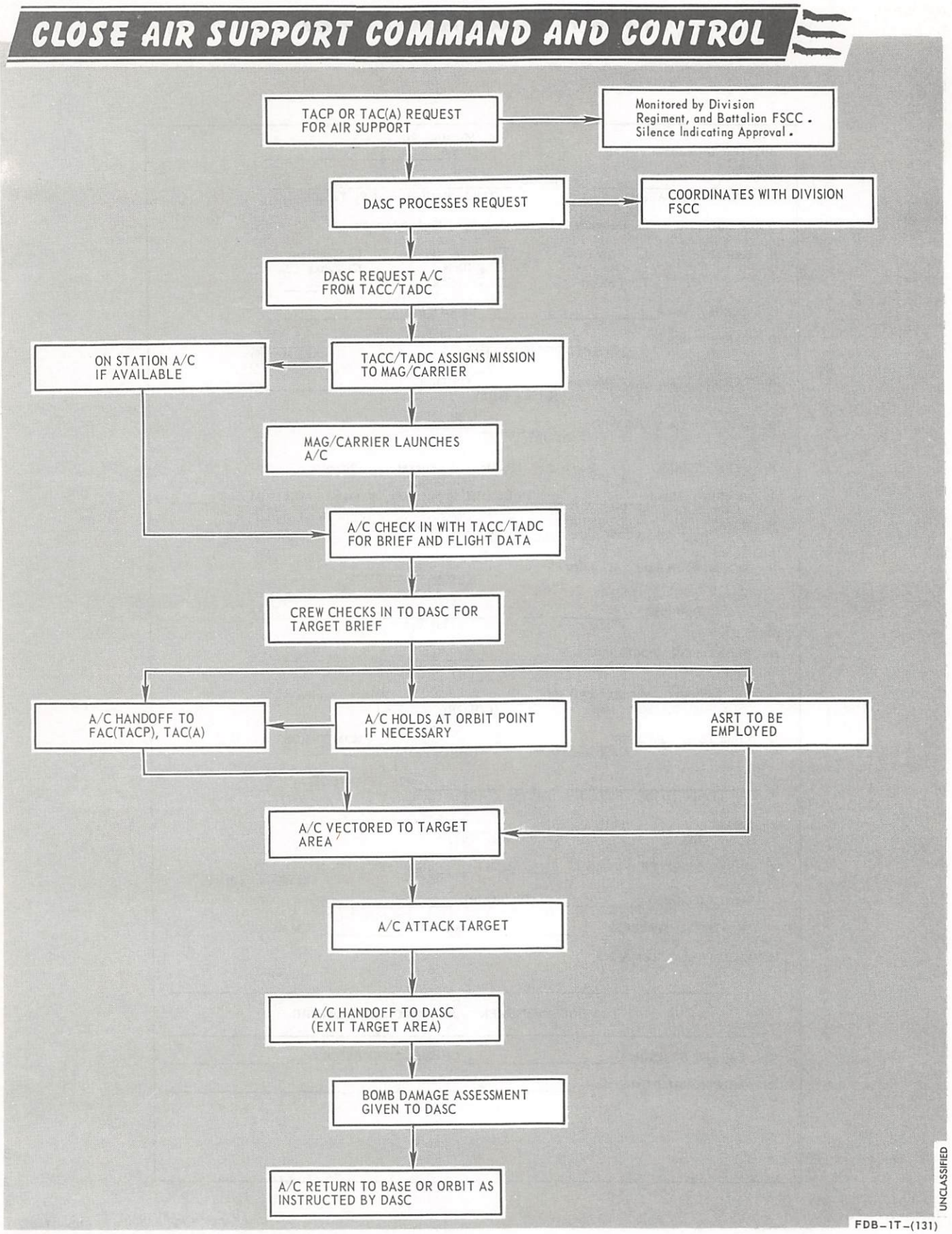

CLOSE AIR SUPPORT COMMAND AND CONTROL
TACP OR TAC(A) REQUEST FOR AIR SUPPORT
Monitored by Division Regiment, and Battalion FSCC. Silence Indicating Approval.
DASC PROCESSES REQUEST
COORDINATES WITH DIVISION FSCC
DASC REQUEST A/C FROM TACC/TADC
ON STATION A/C IF AVAILABLE
TACC/TADC ASSIGNS MISSION TO MAG/CARRIER
MAG/CARRIER LAUNCHES A/C
A/C CHECK IN WITH TACC/TADC FOR BRIEF AND FLIGHT DATA
CREW CHECKS IN TO DASC FOR TARGET BRIEF
A/C HANDOFF TO FAC(TACP), TAC(A)
A/C HOLDS AT ORBIT POINT IF NECESSARY
ASRT TO BE EMPLOYED
A/C VECTORED TO TARGET AREA
A/C ATTACK TARGET
A/C HANDOFF TO DASC (EXIT TARGET AREA)
BOMB DAMAGE ASSESSMENT GIVEN TO DASC
A/C RETURN TO BASE OR ORBIT AS INSTRUCTED BY DASC
UNCLASSIFIED
FDB-1T-(131)

Figure 2-33 (U)

the bomb frag patterns. The frag pattern for each bomb may be found in this manual. The time interval also allows the controller an opportunity to assess the impact and adjust for the next impact. The interval will also assist the controller in maintaining his lookout doctrine.

e. Call *in* and *off* target on each run to facilitate controller acquisition of each aircraft. This will also facilitate clearance as each aircraft must receive a clearance to drop on each run. The calls *in* and *off* target by attacking aircraft allow the controller to perform other functions while maintaining knowledge of each aircraft's position in the pattern.

(U) SUMMARY OF CLOSE AIR SUPPORT

a. Maximum lookout doctrine in the target area.

b. Utilize offset trail formation coming into the target area to allow all aircrews maximum lookout doctrine for the controller, target, terrain avoidance, other aircraft, and enemy ground fire.

c. Visually acquire the controller and target.

d. Maintain two way communication between aircraft and controller.

e. Maintain attack heading or run-in heading as assigned by the controller.

f. Evaluate the terrain around the target area where pullout altitudes could be affected.

g. Where possible, take advantage of the sun position during entry, attack, and departure from target area.

h. Maintain approximately 30 second interval between attacking aircraft to avoid the frag pattern and to allow the controller time to assess damage.

i. Call *in* and *off* target on each run. This facilitates the controller in acquisition of each aircraft in the pattern.

j. Must receive a clearance to drop ordnance on each run as the ground situation may dictate a change.

k. KNOW THE LOCATION OF FRIENDLY GROUND UNITS AT ALL TIMES AND BE ACCURATE.

SPECIAL MISSIONS

(U) GENERAL

(U) Special missions include all missions not previously defined including, but not limited to, the following:

a. RESCAP Mission. A detailed description follows.

b. Helicopter Escort Mission. A detailed description of the Helicopter Escort Mission follows.

c. Psychological Warfare Mission. Pyschological warfare missions is defined as leaflet drops and includes the heckler missions.

d. ECM Mission. Refer to the Secret Supplement.

e. TPQ-10 Mission. A detailed description of AN/TPQ-10 Ground Controlled Radar Bombing follows.

f. Team Bombing Mission. The F-4 may be used to deliver weapons while flying wing position on other all weather aircraft. Thorough preflight planning is essential for effective team bombing. The flight leader must be aware of the F-4 capabilities and limitations. Whenever possible, an alternate visual target and delivery mode should be planned. Refer to Safe Escape Considerations, part 3.

NEW

g. Night Attack Mission. A detailed description of a typical Night Attack Mission follows.

NEW

h. Laser Mission. A detailed description of the laser mission follows. Portions of the description and tactics are contained in (Secret) NAVAIR 01-245FDB-1T(A), section II.

(U) RESCAP

(U) The primary concern on a Rescap mission is the safe and rapid extraction of the survivors. In order to accomplish this the following considerations are in order.

a. Obtain visual/voice contact to assure status and authenticity of survivors.

b. Vary flight vigilance with respect to threat area. Do not lose maneuverability in an airborne threat area - there may not be room in the rescue vehicle for more passengers.

c. Be prepared to escort or direct the rescue aircraft into the pickup area, and escort during egress.

d. If weapons have been optimized for the mission the survivors can be protected down to the mean lethal radius of the weapons be used. If weapons have not been optimized for the mission insure that the flight knows precisely where the survivors are before any ordnance is expended. Preferred ordnance is same as for close air support.

e. The rescue vehicle will be at its most vulnerable status at pickup time. This is when cover becomes most critical.

f. Act as on-scene rescue commander until relieved by a designated rescue coordinator.

(U) HELICOPTER ESCORT

(U) Escort retaliatory firepower creates a psychological deterent to suppress enemey fire. Thorough escort briefing is mandatory and should include rendezvous, communication procedures, helicopter flight track and altitude, number of helicopters, and landing zones (LZ) location. The track and maneuvering of the helicopters, the weather, and the terrain combine to dictate the escort pattern techniques required to reduce or suppress enemy fire.

(U) Enroute Tactical Considerations

(U) Radio contact with the helicopter flight leader should be established prior to rendezvous. In-trail formation should be used to achieve spacing of the escort aircraft, while approaching the rendezvous. When visual contact between the two elements is confirmed, the helicopters will depart on track. The

escort aircraft will then establish a race track pattern around the helicopter flight to provide a continuous series of potential firing passes. If the helicopter flight reports ground fire, the escort aircraft in the firing pass should respond with retaliatory fire. Retaliatory fire usually causes the enemy to cease fire. A typical escort pattern is shown in figure 2-34.

(U) Tactical Considerations in the Landing Zone

(U) Helicopters are most vulnerable while landing and lifting from the LZ. If intensive enemy resistance is anticipated in the LZ area, a preparatory strike should precede the helicopter landing. Cover aircraft in the LZ area should maintain a race-track pattern similar to the enroute pattern. A series of repeated potential firing passes should be directed against high ground vantage points within mortar and/or small arms range where effective enemy fire will normally originate. Repeated apparent tracking or firing runs, even though the enemy is not sighted, should be continued until the helicopters depart the area. The enroute escort pattern is then resumed until detached by the helicopter flight commander.

(U) AN/TPQ-10 GROUND CONTROLLED RADAR BOMBING

(U) The AN/TPQ 10 Radar Course Directing Central is an all-weather ground controlled bombing system operated by U.S. Marine Corps Air Support Radar Teams (ASRTs). The Marine Air Support Radar Team is an operational unit of the Marine Air Support Squadron. Under operational conditions the Air Support Radar Team is deployed to support the amphibious operation as a combat support unit and serves in the capacity of a forward air controller.

(U) With the Radar Course Directing Central, AN/TPQ 10 system, the Air Support Radar Team provides the amphibious Troop Commander with active and continuous control of close air support during all conditions of weather and visibility. The primary mission of a Marine Air Support Radar Team is to provide, operate and maintain facilities for the Radar Control of aircraft, for close or direct support, during periods of reduced visibility. The secondary missions assigned to a Marine Air Support Radar Team include:

a. Air Support missions against targets hidden by smoke, terrain features, etc.
b. Aerial resupply or resupply in forward areas.
c. Positioning of flare dropping aircraft over target areas.
d. Guidance of photo reconnaissance aircraft.
e. Assisting helicopters in casualty evacuation from forward areas.
f. Guiding helicopters assaults to and from the objective area.
g. Limited GCA.
h. Glide Bombing.

(U) The radar portion of the AN/TPQ 10 is a monopulse tracking radar, operating on the X band, very similar to the tracking radar systems of SAM missile sites. In order to obtain accuracy the radar and the computers must perform with pin point accuracy. Most search type radars have a ± 3 percent accuracy error in range. Since such an error is unsatisfactory for ground controlled bombing requirements, the TPQ was developed to use a narrow radar beam (known as the pencil beam). This narrow beam in conjunction with monopulse timing circuits provides very accurate aircraft position sensing.

(U) Typical TPQ 10 Mission

(U) Having surveyed the precise location of the radar site and oriented to a known direction, the Air Support Radar Team is ready to commence operation. The team receives a mission from the Direct Air Support Center over the Tactical Air Request (TAR) net. All necessary target information is furnished in the mission briefing, the assigned aircraft would contact the ASRT over the Tactical Air Direction (TAD) net. Then by use of TACAN, pre-assigned orbit points, Organic Search Radar (UPS-1), or search radar from another control agency, the aircraft is acquired, identified, and turned into the general direction of the target. At this point the bomb run may be started.

(U) In both the automatic and manual run the controller must insert target altitude, radar altitude, computed target coordinates, ballistic winds, time of fall, and true airspeed desired. The operator must, by manually turning the azimuth, elevation, and slant range handwheels, search for the aircraft. After the operator has searched for, acquired, and locked on the aircraft, the radar system begins to track automatically. The controller then engages the computers which solve the bombing problem.

(U) In the automatic run, the radar system controls the aircraft to a point in space from which a bomb is released to hit the assigned target. Left and right turns, and ordnance release signals are computed and transmitted to the aircraft. It must be understood that in order to run this type of operation the aircraft must have certain components in the aircraft compatible with the Radar Course Directing Central components. These are the AN/ARW-67 and a two axis stabilization system (AFCS or autopilot) into which the commands from the AN/ARW-66 in the TPQ-10 are received and channelized. From the ARW-67, the aircraft derives left or right turn commands, armstrong command, and drop command, on coded frequencies. During this type run, all the pilot need do is maintain a constant airspeed, hold altitude, and activate the armament switches.

(U) The second type run (normally used by the F4) is called a manual or voice vector run. The TPQ-10 can control any type aircraft not equipped with the Ground Controlled Bombing System. In addition to inserting the target information the Strike Controller verbally vectors and directs the pilot of the aircraft. Voice transmission is kept to a minimum and only necessary heading, altitude, and airspeed changes are given. When the aircraft reaches a point 5,000 meters from the release point, the controller commands the pilot to arm his drop switches. Transmission should be 5,000 METERS, ARMSTRONG: 2,000 METERS, STBY: 1,000 METERS, STANDBY, MARK MARK. At the command MARK, the pilot will release his ordnance.

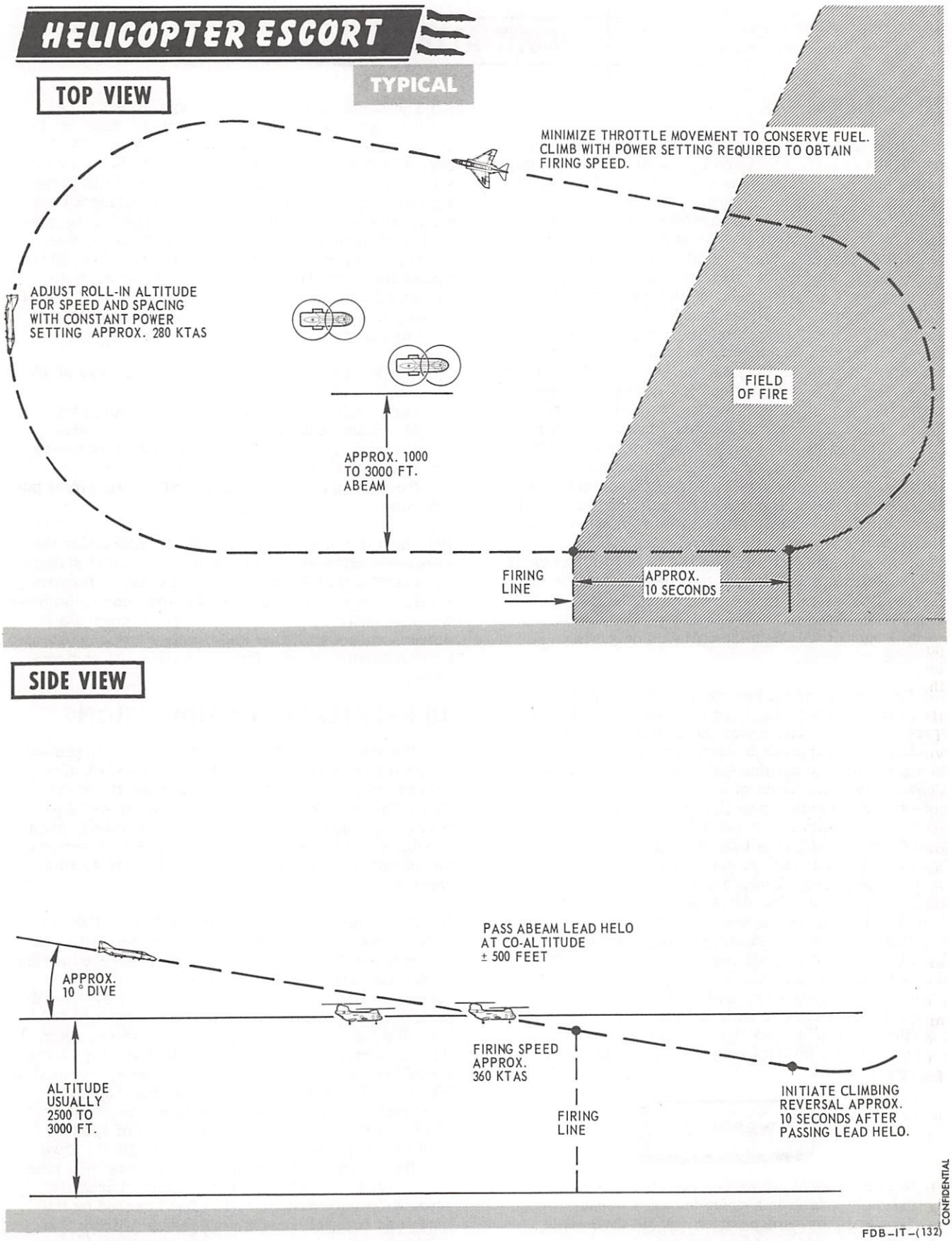

HELICOPTER ESCORT
TYPICAL
TOP VIEW
MINIMIZE THROTTLE MOVEMENT TO CONSERVE FUEL. CLIMB WITH POWER SETTING REQUIRED TO OBTAIN FIRING SPEED.
ADJUST ROLL-IN ALTITUDE FOR SPEED AND SPACING WITH CONSTANT POWER SETTING APPROX. 280 KTAS
APPROX. 1000 TO 3000 FT. ABEAM
FIELD OF FIRE
FIRING LINE
APPROX. 10 SECONDS
SIDE VIEW
PASS ABEAM LEAD HELO AT CO-ALTITUDE ± 500 FEET
APPROX. 10 ° DIVE
ALTITUDE USUALLY 2500 TO 3000 FT.
FIRING SPEED APPROX. 360 KTAS
FIRING LINE
INITIATE CLIMBING REVERSAL APPROX. 10 SECONDS AFTER PASSING LEAD HELO.
CONFIDENTIAL
FDB-IT-(132)

Figure 2-34(C)

NIGHT ATTACK

(U) GENERAL

(U) Of all factors involved in night operations, sky conditions greatly affect and play a major role in determining the effectiveness of paraflare illumination and mission results. Low ragged overcasts, light fog, or drizzle will cause paraflare light to be diffused to such an extent that flight instruments must be used constantly. Such conditions may prevent effective attacks. Smoke and haze also significantly reduce paraflare effectiveness and increase the probability of spatial disorientation. When visibility is less than 5 miles, target acquisition without paraflares, is highly improbable. With paraflares, vertigo-inducing side effects may be encountered. One of the side effects is the "Milk Bowl", encountered when paraflares are burning in reduced visibility conditions. The total world is centered around the paraflare. This creates a 3-dimensional sphere of light. Difficulty may be encountered in determining aircraft attitude without reference to flight instruments. The "Milk Bowl" effect also tends to make target acquisition difficult and induce spatial disorientation. Spatial disorientation (vertigo) is an inherent problem in all night operation. To minimize the possibility of vertigo, the following procedure has been established for use in night attack: armament switch changes, mil depression changes, fuel checks, and other similar cockpit checks will be accomplished only when straight and level.

(U) Terrain definition becomes limited to a small area directly under the burning paraflares. If the target is not directly under the paraflares, difficulty is usually encountered in acquiring it and keeping it in sight while positioning the aircraft for an attack. Conversely, conditions of high overcast provide a good background for area lighting. An area so illuminated may serve as a suitable reference for VFR type flight. Paraflares burning under a medium or low overcast will also produce added reflected light in the target area. However, the reflected light can also produce deceiving depth perception problems. Additionally, operation under an overcast places the aircraft in a position where enemy gunners can spotlight the aircraft against the paraflare reflection in the overcast. The added light may be sufficient to permit the gunners to visually track attacking aircraft. Clear weather, with natural illumination, provides excellent area lighting and attacks can be executed with minimum reference to flight attitude instruments.

WARNING

Rockets should not be selected for use during night attack in a defended area because it reveals aircraft position. A 30° dive angle should be considered maximum for night attack.

(U) The success of any type of night strike is dependent upon positive aircraft control. Night operations involve all of the adverse conditions which each aircrew has been warned to avoid in every instrument training course ever offered. With proper vigilance by the 2-man crew in the F-4, night operation can be conducted with safety. The 2-man concept is vital to aircraft positioning, weapons delivery, recovery, and target departure. The RIO operates the navigation and radar equipment. Both RIO and Pilot must monitor instruments and aircraft attitudes. Some of the coordination techniques that have proven to be effective are:

a. Vertigo Deterent - One man must always be on the instruments.
b. Dive angle and release altitude coordination.
c. Minimum altitude and airspeed coordination.
d. Unusual altitudes, prevention and/or recovery.
e. Armament switch positioning.
f. Visual acquisition of the target during initial positioning.

(U) The Pilot should fully utilize his RIO under the adverse conditions encountered during night strikes to avoid the possibility of losing control of the aircraft, to increase navigation accuracy and to improve weapons delivery reliability. Each aircrew must discuss responsibilities and practice crew coordination techniques to be effective in the night environment.

(U) PARAFLARE CONSIDERATIONS

(U) The MK 24 and MK 45 paraflares are dispensed rearward from the SUU-40/A and SUU-44/A dispenser, or, are released freefall from the MER/TER. Refer to External Stores Limitations, Appendix A. The dispenser contains four tubes, each capable of carrying two paraflares. For description and paraflare delivery data, refer to part 4, this section.

(C) The paraflare burns for either 150 or 180 seconds, depending upon the Mod, to produce illumination rated at 2 million candle power. Approximately 15 seconds are required for paraflares to reach maximum intensity after ignition. Directly beneath each burning paraflare, is an area of subdued light caused by paraflare design characteristics. Paraflare coverage is a nominal 1-mile diameter circle. Paraflares should be set to burn out at approximately 500 to 1000 feet AGL. Attack conditions become marginal after the burning paraflare drops below 500 feet AGL. This is due to the area of subdued light directly beneath the burning paraflare. Two paraflares are released each time a dispenser tube is activated. If both paraflares ignite, paraflare separation (approximately 150 feet) caused by ballistic and fuze tolerances, causes an overlap that brightens the area of reduced intensity directly beneath each paraflare. Against most targets, and for

(C) certain delivery maneuvers, it may be necessary or desirable to release four or more paraflares in a line. Also, if more paraflare separation is deemed necessary, paraflare fuzes could be set with different delay times.

(C) The optimum over-all attack conditions prevail when the paraflares bracket the target and burn out at 500 to 100 feet AGL. In some cases, it may be desirable to concentrate the paraflare light in front of the target; for example, when performing strafing attacks or low-level/low-angle bombing. In this case, the initial paraflares should be positioned at ignition approximately 4000 feet short of the target and the second pair approximately 1000 feet short. For targets with little vertical development, it may be necessary to position the paraflares directly over the target to obtain maximum paraflare light.

(C) The optimum release altitude varies with the type of delivery maneuvers being performed and the recovery altitudes of the attack aircraft. For example, low-level/low-angle deliveries require the attacking aircraft to operate in the lighted area under the paraflares, while the medium angle deliveries (20° to 30° dive) enable the attackers to recover above the paraflare burning altitude and out of the lighted area. The optimum paraflare release altitude is between 3000 to 5000 feet AGL. This keeps the paraflare aircraft above the range of small arms fire and enables accurate placement of paraflares. The ejection fuze delay and ignition fuze delay timers are set as required to obtain fuze burnout at the desired altitude.

CAUTION

If multiple attacks are made in the same target area, the parachutes of the burned-out paraflares may become a hazard. After a paraflare burns out, the weight reduction allows the parachute to ride on thermals and remain aloft for many minutes.

(U) The aircraft will be flown primarily by referencing the flight instruments in the delivery patterns. The RIO will monitor the flight instruments and advise the Pilot anytime the bank angle exceeds 60° to 90°, the pitch angle exceeds 30° and the airspeed approaches 250 KCAS. Delivery recoveries will be made with a wings-level pullout, obtaining 4 G's in 2 seconds and *with reference to the ADI* to minimize the vertigo-inducing effect of the bright paraflare illumination area.

(U) Paraflare Search Pattern With Like Aircraft

(C) Enroute to the target, the flight deploys into a tandem, two attack disposition. The tandem-trail position places the second aircraft in an optimum position to immediately execute an attack on an elusive target illuminated by the paraflare released from the lead aircraft. The trail aircraft should use the radar search mode to: (1) maintain approximately 5 to 7 nautical mile radar trail, (2) maintain position, and (3) to detect bogeys. Turns are called by the lead aircraft and executed at a prebriefed bank angle. External lights are extinguished as the flight approaches enemy territory to avoid detection.

(C) The formation should provide adequate terrain clearance and should position the flight between the AAA and SAM threat. The wingman will maintain an approximately 5 to 7-nautical mile radar trail offset 5° to 10°, and level with the leader. Figure 2-35 illustrates a typical night attack with two aircraft. As the flight approaches the target, the leader establishes an initial run-in heading and calls when dropping a paraflare. After paraflare release, the leader executes a called 180° turn while climbing to the roll-in altitude. The leader's paraflare is set to ignite 20 seconds after release. When the paraflare ignites, the wingman should be approximately 3 miles from the paraflare. At paraflare ignition the wingman may perform a pop-up maneuver to attain the proper dive angle for the attack (normally a 20° to 30° dive attack). If a target is not sighted, the wingman follows the leader. The leader, upon completing the 180° turn, should be prepared to initiate or continue the attack. The search and destroy patterns continue as necessary to effectively illuminate the target area. Upon target identification/detection the number of weapon delivery runs will be determined by the tactical situation, i.e. bingo fuel time, the number of paraflares remaining and/or the presence of ground fire.

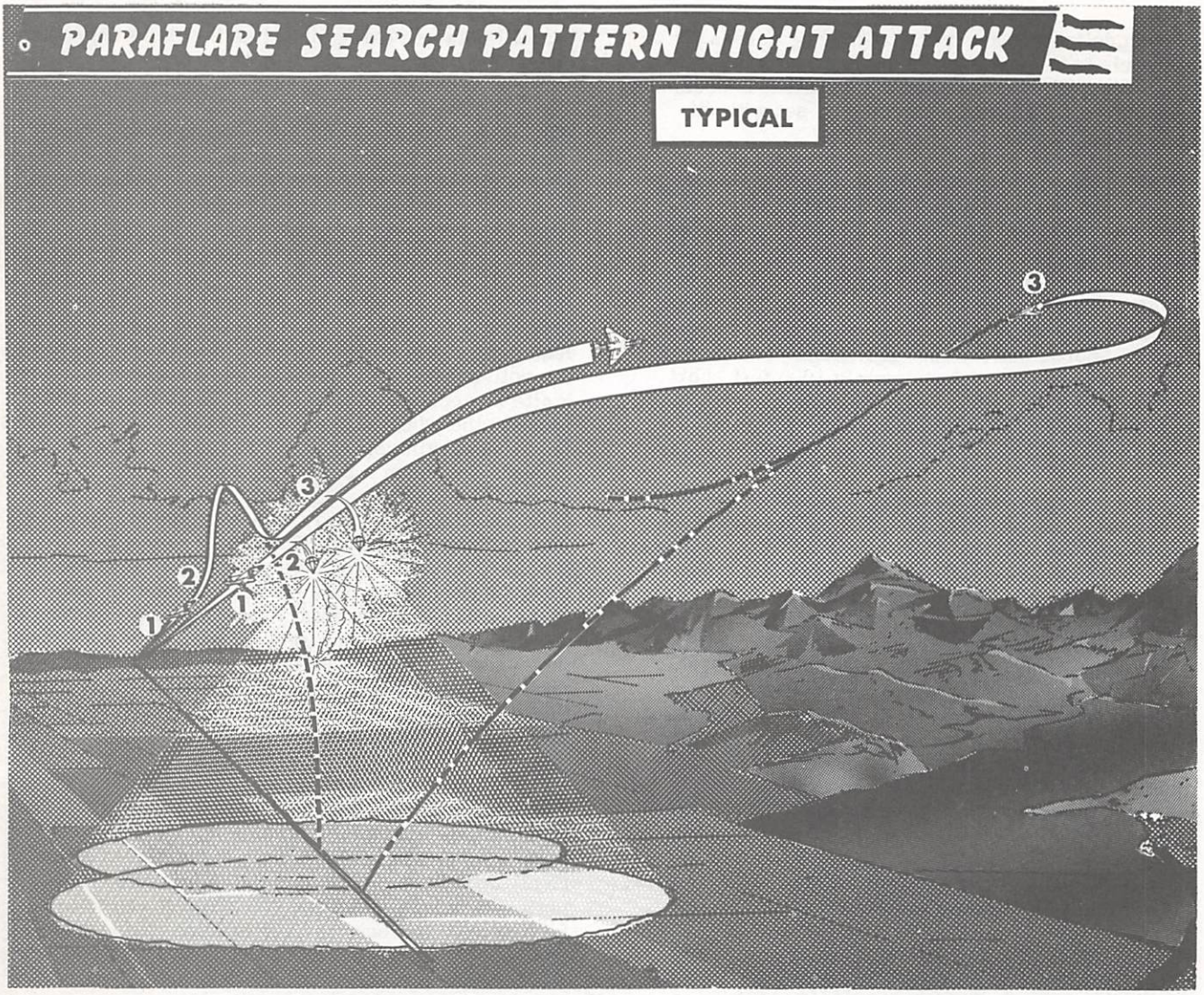
(U) It is mandatory that each aircrew know the location and intention of the other at all times, therefore, proper use of the radio is essential to effectively coordinate all phases of the mission. To maintain separation of the two aircraft and to establish positive location, use heading calls or clock position (first paraflare is 6 o'clock, last paraflare is 12 o'clock).

(U) Night Attack With Unlike Paraflare Drop Aircraft

(C) When target illumination is provided by other type aircraft, such as C-130 and C-117 aircraft, special procedures will apply (figure 2-36). F-4 aircraft insertion altitudes and tactics may be varied from visual formation with external lights on to external light off and radar trail with altitude separation. Rendevous with the paraflare drop aircraft is usually accomplished with external lights off in radar trail. Upon arrival in the target area, specifies on terrain, weather, weapons, etc., will determine the paraflare drop and the strike tactics. The paraflare drop aircraft will establish either a left or a right hand race track pattern which will allow the F-4 aircraft to set up the attack pattern on the opposite side of the target. As in all night missions, it is imperative that all aircraft be aware of the position of the other aircraft at all times. This requires judicious use of radio calls on roll in, off target, and position from target. Some paraflare drop aircraft may be lighted along its top surface to facilitate top side recognition; in any case, the F-4's must ensure that the paraflare drop aircraft is clear of the target before commencing the attack.

PARAFLARE SEARCH PATTERN NIGHT ATTACK

TYPICAL



1 WINGMAN IN 5 TO 7 NM RADAR TRAIL.

2 WINGMAN MAY INITIATE A POPUP WHEN LEADER'S PARAFLARE IGNITES (20 SECONDS AFTER RELEASE) APPROX. 3 MILES FROM FLARE, OR CONTINUE STRAIGHT AHEAD SEARCH.

3 LEADER'S POSITION WHEN WINGMAN'S PARAFLARE IGNITES.

4 IF NO TARGET IS SIGHTED, LEADER CONTINUES SEARCH PATTERN; WINGMAN FOLLOWS THE LEADER.

BOTH AIRCRAFT:
AFTER RELEASE, CALL AND INITIATE A CLIMBING TURN TO ROLL IN ALTITUDE.

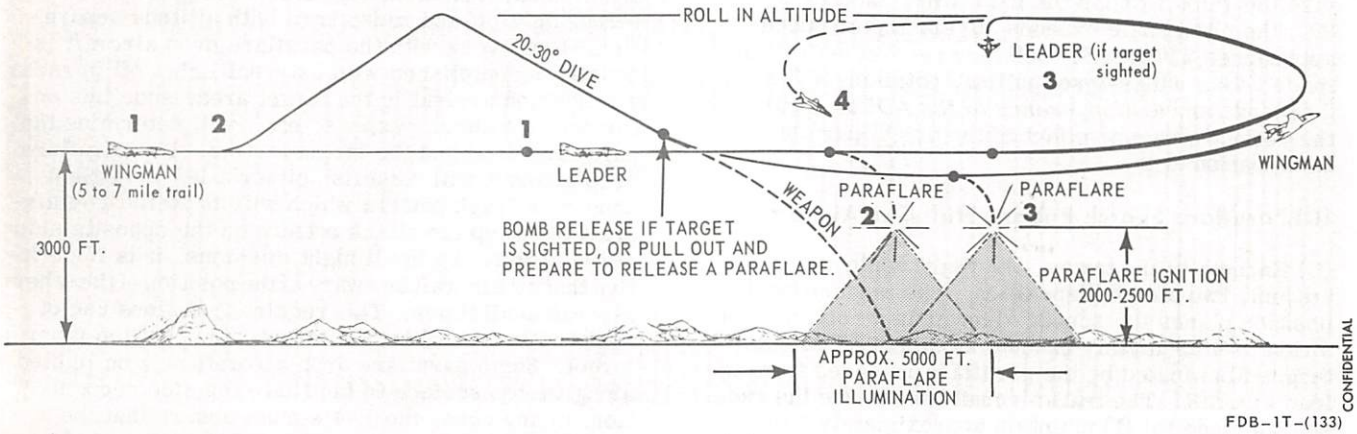


Figure 2-35 (C)

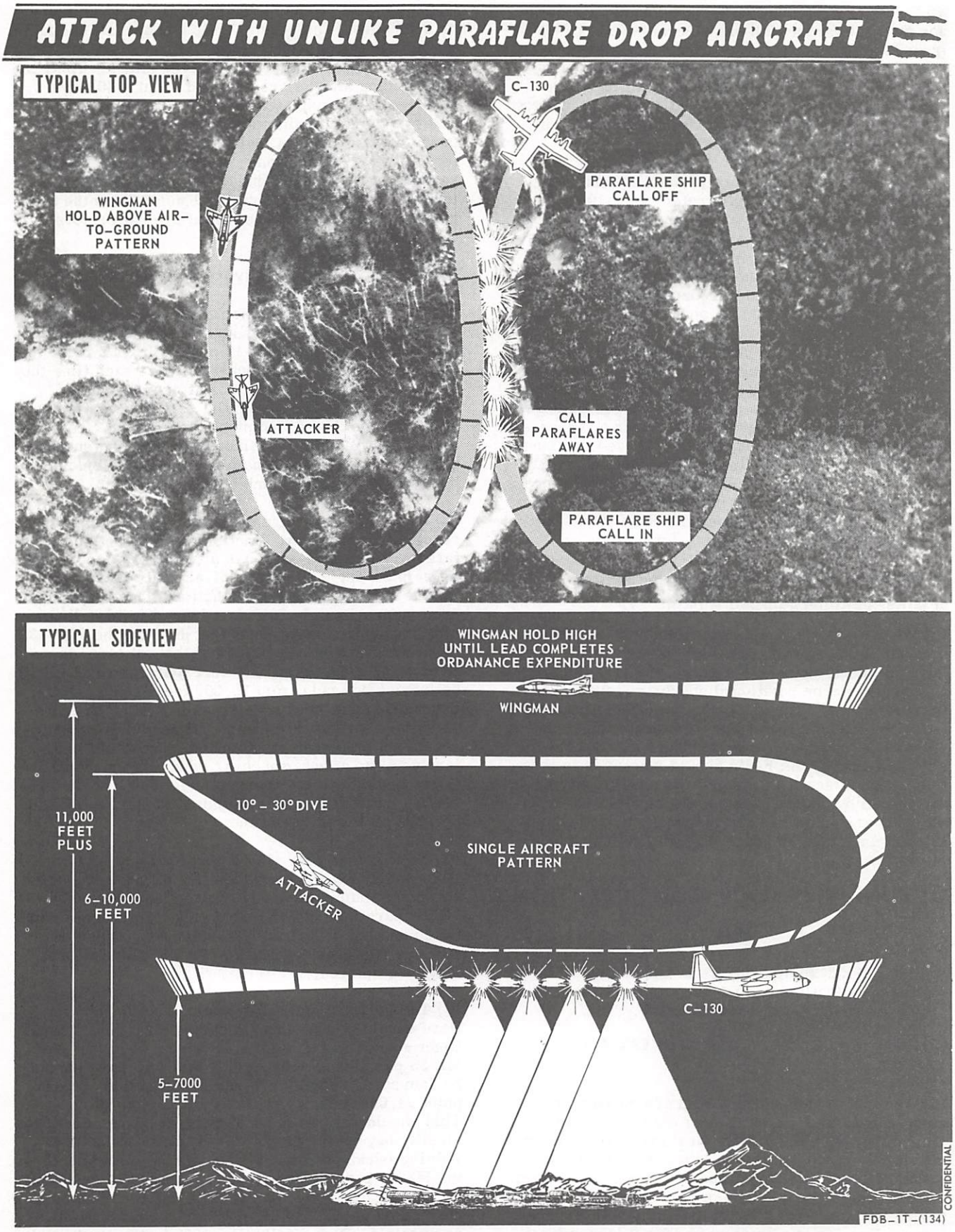

ATTACK WITH UNLIKE PARAFLARE DROP AIRCRAFT
TYPICAL TOP VIEW
C-130
PARAFLARE SHIP CALL OFF
WINGMAN HOLD ABOVE AIR-TO-GROUND PATTERN
ATTACKER
CALL PARAFLARES AWAY
PARAFLARE SHIP CALL IN
TYPICAL SIDEVIEW
WINGMAN HOLD HIGH UNTIL LEAD COMPLETES ORDANANCE EXPENDITURE
WINGMAN
11,000 FEET PLUS
6-10,000 FEET
10° - 30° DIVE
SINGLE AIRCRAFT PATTERN
ATTACKER
C-130
5-7000 FEET
CONFIDENTIAL
FDB-1T-(134)

Figure 2-36 (C)

(C) Strike aircraft may be assigned altitude separation over the target with one aircraft in the air-to-ground pattern and the other aircraft holding above the target. When the first aircraft has completed ordnance expenditure, the next aircraft descends into the air-to-ground pattern while the first aircraft clears the pattern and moves into a position to call BDA or AW/AAA fire location.

(C) Strike aircraft may work in the same pattern simultaneously if radio calls referring to position are frequently used. Normally, more than two aircraft (with external lights out) in the attack results in a wide, loose pattern because of the aircrew's concern for potential mid-air collision. In addition, radio calls must be used to reduce the time between runs to approximately 30 seconds.

(C) Some degree of fire suppression can be accomplished while two aircraft are in the pattern simultaneously. The primary attack aircraft should concentrate on the optimum pattern for target exploitation, while the fire suppression aircraft maneuvers to follow. When AW/AAA fire is observed tracking the attack aircraft, the fire suppression aircraft should be in position to roll in and expend ordnance on the AW/AAA site while it is firing. Egress from the target area may be accomplished in radar-trail or in normal, visual, lights on, formation.

(U) Night Attack With Moving Target Indicator (MTI) or Other Sensor-Equipped Aircraft

(C) When a night attack is conducted with an unlike aircraft equipped with an MTI or other special sensing equipment, the F-4's should fly in trail formation if possible and be positioned approximately 5 miles in trail of the sensor aircraft. Upon detecting a target, the sensor aircraft may illuminate the target, commence an attack, or both. When directed by the sensor aircraft, the F-4's should maneuver to position for an attack if the target appears lucrative (evidenced by secondary explosions, etc.). If multiple runs are made, all aircraft must know the position and intent of the other via radio calls at roll-in, off target, etc.

(U) ZUNI PARAFLARE CONSIDERATIONS

Note

The MK 33 Zuni paraflare is recommended for illumination of point targets and *is not* recommended for reconnaissance.

(U) ZUNI MK 33 PARAFLARE DELIVERY AND TACTICS

(C) The tactics described herein are based on two basic considerations. The first consideration is the method by which the MK 33 paraflares are to be positioned over the target. One technique involves referencing onboard aircraft radar to position the paraflare launch aircraft at the proper distance from the target. This method essentially limits MK 33 paraflare deliveries to a straight and level launch from 5500 feet AGL. A second technique employs the aircraft gunsight and the MK 33 paraflares may be launched from either the straight and level delivery or a 10° dive. The second basic consideration affecting the tactics provided is the ordnance and delivery technique employed in the follow-on attack. Tactics for bombing attacks are oriented about a 30° dive. Rocket and strafing attacks employ 20° dive deliveries. Except for situations in which the pathfinder/buddy bomber concept may be used, all tactics are for two aircraft (section). In all cases, the MK 33 paraflares will be launched from a point approximately 24,000 feet or 4 nautical miles from the target in order to position the paraflare pattern over the target area.

(U) MK 33 Paraflare Delivery Considerations

(C) For optimum employment, MK 33 paraflares should be delivered singly at 1-second intervals. This requires setting the LAU-10 pod on SINGLE prior to launch so that the Zuni rocket will fire each time the pickle is depressed. On aircraft prior to 152305, rockets will fire first from the port wing station selected and on the second pickle depression, from the starboard wing staion. Aircraft 152305 and subsequent will fire rockets from both wing stations selected each time the bomb button is pressed.

(C) All MK 33 paraflare deliveries are designed to result in the paraflare functioning 3000 feet above the target. The Zuni rocket has a trajectory drop of 110 mils (plus angle of attack of aircraft FRL) from launch to MK 33 paraflare function. This trajectory drop (approximately 2600 feet from a level delivery) plus the approximate 2400 feet lost by the MK 33 paraflare while burning dictates that all level deliveries be made from 5500 feet AGL, and that all 10° deliveries be made from 10,000 feet AGL or above, depending upon release airspeed. These altitudes are based on two premises: (1) that the paraflare should not be placed at an altitude that would interfere with the attack maneuver, and (2) that the paraflare should burn out approximately 500 feet AGL to realize optimum surface illumination during the 136 seconds of MK 33 burn time.

(C) No less than four MK 33 paraflares should be launched on any run for which the MK 33 is the sole source of illumination. During tactics where the MK 33 paraflare is to be used only for general orientation and MK 24 paraflares are to supplement the MK 33 paraflares, as few as two MK 33 paraflares may be employed.

(C) The primary method by which the MK 33 paraflare should be delivered is during straight and level flight and launched at 350 KTAS from 5500 feet AGL. MK 33 paraflares delivered by this technique should be launched singly, at 1-second intervals from a point 24,000 feet to 4 nautical miles from the target. This should place at least 50 percent of the paraflares slightly beyond the target and result in some backlighting (shadows toward the attacking aircraft). If the MK 33 paraflares are to be launched by referencing target distance from onboard radar, fire the paraflares as near to 24,000 feet to 4 nautical miles as possible. Radar deliveries require approximately a 15-nautical mile run-in to get squared away. For release airspeeds other than 350 KTAS, see part 4

(C)
for MK 33 down range travel. If the target/area can be seen visually from the distance required, a gunsight delivery may be made using the mil settings provided in the Sight Angle charts, part 4. It is stressed that the gunsight setting for the MK 33 paraflare delivery will probably have to be changed, subsequent to paraflare launch, to that required for the ordnance/maneuver to be used in the follow-on attack.

(C) The secondary method by which the MK 33 paraflares may be launched is from a 10° dive maneuver. In the dive maneuver the paraflares are launched at no less than 10,000 feet AGL and 300 KTAS. The down range travel of the MK 33 paraflare may be derived from part 4 for all 10° deliveries from various release airspeeds and altitudes. It is considered that all dive deliveries of the MK 33 paraflare will involve the use of the gunsight for aircraft positioning. The sight settings for the 10° dive delivery of the MK 33 paraflare are provided in part 4, Sight Angle charts.

(C) The 1-second launch interval recommended for MK 33 paraflares provides approximately 600 feet between functioning paraflares launched at 350 KTAS. If it is desired to vary the distance between function points of the MK 33 paraflares, the launch interval may be adjusted accordingly for various airspeeds. Figure 2-37 is a chart by which MK 33 paraflare spacing may be determined for several different launch intervals and airspeeds. These distances are approximate and some variations will often exist due to the deviations in fuze function time(s) of the MK 33 paraflare. Firing intervals in excess of 1-second are not recommended with the MK 33 paraflare is delivered by the 10° dive maneuver. In the dive maneuver, the vertical velocity of the aircraft is imposed on the Zuni/MK 33 and paraflare function altitudes may be adversely affected (too low). Additionally, the firing altitude is much more critical for correct placement of the MK 33 paraflare from the dive maneuver and extended firing intervals are likely to result in the last paraflare(s) being launched well below the desired altitude.

(C) While the 10° toss maneuver is not recommended for MK 33 paraflare delivery, information is provided for those tactical situations where it may be desired. Part 4 shows down range travel for the MK 33 paraflare 10° toss from 2000 feet AGL at various airspeeds. A toss technique which may be used is as follows:

a. Run-in at 500 KTAS at 1500 feet AGL.
b. Commence a 2.5 G pullup at 28,000 feet from the target and stabilize a 10° climb attitude.
c. Launch the MK 33 paraflares while passing 2000 feet AGL.

(C) Not only is the toss maneuver considered difficult for the pilot to perform, but the MK 33 paraflare placement accuracy is poor.

(U) MK 33 Attack Tactics

(C) There are several procedures which are common to all of the following tactics presented and illustrated in figure 2-37.

a. Only two aircraft are considered in the illustration and the following discussion.
b. The aircraft designated by A in figure 2-37 is the lead aircraft and B designates the wingman.
c. Flare launch is designated by T_O (time zero) and aircraft positions are related to this plus the applicable number of seconds (i.e. T_O +40 seconds). The MK 33 paraflare has an average fuze function time of 16 seconds. Therefore, the MK 33 paraflare should be expected to function at T_O +16 seconds. Usable light from the MK 33 paraflares will usually be available after T_O +20 to 25 seconds. The average burn time of the MK 33 paraflare is 136 seconds. Accordingly, when only the MK 33 paraflare is used, burnout may be expected to occur at approximately T_O +152 seconds.
d. The MK 24 paraflare can be used to extend the target illumination time. The total target illumination time is then a function of: (1) the time interval after MK 33 paraflare launch and the first MK 24 paraflare release and (2) the MK 24 paraflare ejection and ignition timer settings. The MK 24 paraflare has a burn time of 180 seconds.
e. The tactics shown in figure 2-37 commence with MK 33 paraflare launch (T_O). The timing/positioning is based on both aircraft employing hard turns (at least 3°/second) and maintaining approximately 350 KTAS in the maneuvers prior to roll-in. All tactics have provided at least 30 seconds between the attacks of the two aircraft.
f. For those tactics in which the wingman flys a trail position on the leader, air-to-air tacan or onboard radar should be used to maintain position. All tactics provide for an approximate minimum separation of 2 nautical miles throughout the maneuvers.
g. Except where specifically noted, aircraft A is the MK 33 paraflare launch aircraft and will make the second attack following aircraft B. This procedure gives the MK 33 launch pilot extra time for changing armament switches (and sight settings where applicable) prior to making an attack. The only exception to this generalization is when aircraft B is launching the MK 33 paraflares from a loose wing position or is releasing MK 24 paraflares to supplement the MK 33 paraflares launched by aircraft A.
h. All ordnance deliveries are predicted on:

(1) Bombing runs at 450 KTAS from a 30° dive angle and releasing no lower than 3500 feet AGL.
(2) Rocket and strafing attacks at 450 KTAS from a 20° dive angle and firing no lower than 3000 feet AGL.

Note

All MK 33 paraflare deliveries are designed to provide paraflare function at 3000 feet AGL. Assuming that the MK 33 delivery has been properly executed, the mean rate of descent of 18 fps during suspended burn should put the MK 33 approximately 2600 feet AGL at T_O +40 seconds. Strict attention should be given to weapon release altitudes to avoid aircraft-paraflare collisions and/or recovery below the paraflares.

(C)

i. MK 33 paraflare delivery pilots should close one or both eyes during Zuni launch to avoid degradation of night vision caused by rocket motor ignition.

(C) The following paragraphs describe the various tactics illustrated in figure 2-37, Paraflare Delivery Tactics.

(U) Basic 3 Nautical Mile Trail Tactic

(C) The lead aircraft, A, launches the MK 33 paraflares from a straight and level attitude, 350 KTAS, at 5500 feet AGL. The wingman, aircraft B, is in 3 nautical mile trail at 8000 feet AGL and 350 KTAS. Having launched the MK 33 paraflares, aircraft A executes a 45 degree turn, climbing to 8000 feet AGL. During the climb, the pilot of A changes the armament switches necessary to conduct the follow-on attack. At paraflare launch (T_O), B executes a 15° turn and proceeds at 350 KTAS to the roll-in point at 8000 feet AGL, arriving at T_O +40 seconds. Aircraft B conducts the first attack, followed by aircraft A making a 90° roll-in 30 seconds after aircraft B has called in.

(U) MK 33/24 Paraflare Multiple Trail Tactics

(C) The lead aircraft, A, launches the MK 33 paraflares from a straight and level attitude, 350 KTAS, at 5500 feet AGL followed by a climbing 45° turn to 7000 feet AGL. During the climb, the pilot of aircraft A changes the armament switches necessary to conduct the follow-on attack. At MK 33 paraflare launch, aircraft B continues straight ahead from a loose wing position, descending to 3000 feet AGL over the target area and, by the aid of the light provided by the MK 33 paraflares, releases two or more MK 24 paraflares. The relative position of the two aircraft are shown as A_2 and B_2 in figure 2-37 at T_O +40 seconds. From these positions, A aircraft conducts the first attack as B aircraft executes a climbing 270° turn to make the second attack of the series. The MK 24 paraflares provide ample illumination time for A aircraft to make a second attack after a climbing 270° recovery from the first attack. If time permits, B aircraft may make a second attack, depending upon the ejection/ignition timer setting of MK 24 paraflares. It is considered that this tactic is best for rocket and/or strafing attacks from a 20° dive. MK 24 paraflare fuze settings should allow for an ignition altitude not to exceed 2000 feet AGL when released from 3000 feet or above.

(U) Section Tactic

(C) The section tactic is designed for situations which, for a variety of reasons, require the MK 33 paraflares to be launched by the wingman, aircraft B, on a signal from the flight leader, aircraft A. The aircraft, in section, are at 5500 feet AGL, straight and level and 350 KTAS. Aircraft B launches the MK 33 paraflares on signal from aircraft A, followed by a 90° climbing turn to 8000 feet AGL. During the climb, aircraft B changes the armament switches necessary to conduct the second attack and then makes a 180° turn to the roll-in point, arriving at T_O +80 seconds. At MK 33 paraflare launch (T_O), aircraft A executes a 45° climbing turn at 8000 feet AGL to conduct the first attack at T_O +40 seconds. This tactic can be used in situations where an A-6, A-7, or F-4 aircraft has acted as pathfinder for an aircraft whose radar lacks the range accuracy required for accurate placement of MK 33 paraflares, or; where an aircraft configured with MK 33 paraflares did not have an operable radar and the environmental conditions precluded visual delivery of the paraflares.

(U) Zuni MK 33 Dive Tactic

(C) The lead aircraft, A, launches the MK 33 paraflares from a 10° dive, 350 KTAS at 10,000 feet AGL. The wingman, B, is in 3-nautical mile trail at 8000 feet AGL, flying straight and level at 350 KTAS. After launching the MK 33 paraflares, aircraft A executes a 45° turn, leveling off at 8000 feet or above and then proceeds to the roll-in point. Enroute to the roll-in point, aircraft A changes the armament switches as necessary to conduct the second attack. At paraflare launch (T_O), aircraft B executes at 15° turn and proceeds at 350 KTAS to the roll-in point at 8000 feet AGL arriving at T_O +40 seconds. Aircraft B makes the first attack and is followed by aircraft A at a 30-second interval.

(U) Zuni MK 33 Paraflare Launch Procedures

1. Bomb control switch - DIRECT
2. Weapons switch - CONV ON-NUCL OFF
3. Step reset switch - AS DESIRED
4. Interval switch - AS DESIRED (for ordnance other than MK 33 paraflares)
5. Station select switch - AS REQUIRED (for MK 33 station(s))
6. Weapon select switch - RKT DISP

Note

Aircraft before 142305x fires rockets (MK 33 paraflares) from first the port wing selected and, on the second pickle depression, from the starboard wing station. Aircraft 152305x and up fires rockets from both wing stations selected each time the bomb button is pressed.

7. Nose/tail arm switch - AS REQUIRED (For ordnance other than MK 33 paraflares)
8. Gunsight - AS REQUIRED (For ordnance or MK 24 paraflares to be delivered)
9. Bomb release button - DEPRESS (to fire rockets, MK 33 paraflares)

Note

The above procedures are not printed in the pocket guide. Use the rocket firing checklist to launch the MK 33 paraflares and then use the applicable strike ordnance checklist. Care must be used in switchology to preclude bombing-off the rocket pods, and attempts to fire-off the bomb.

PARAFLARE DELIVERY TACTICS

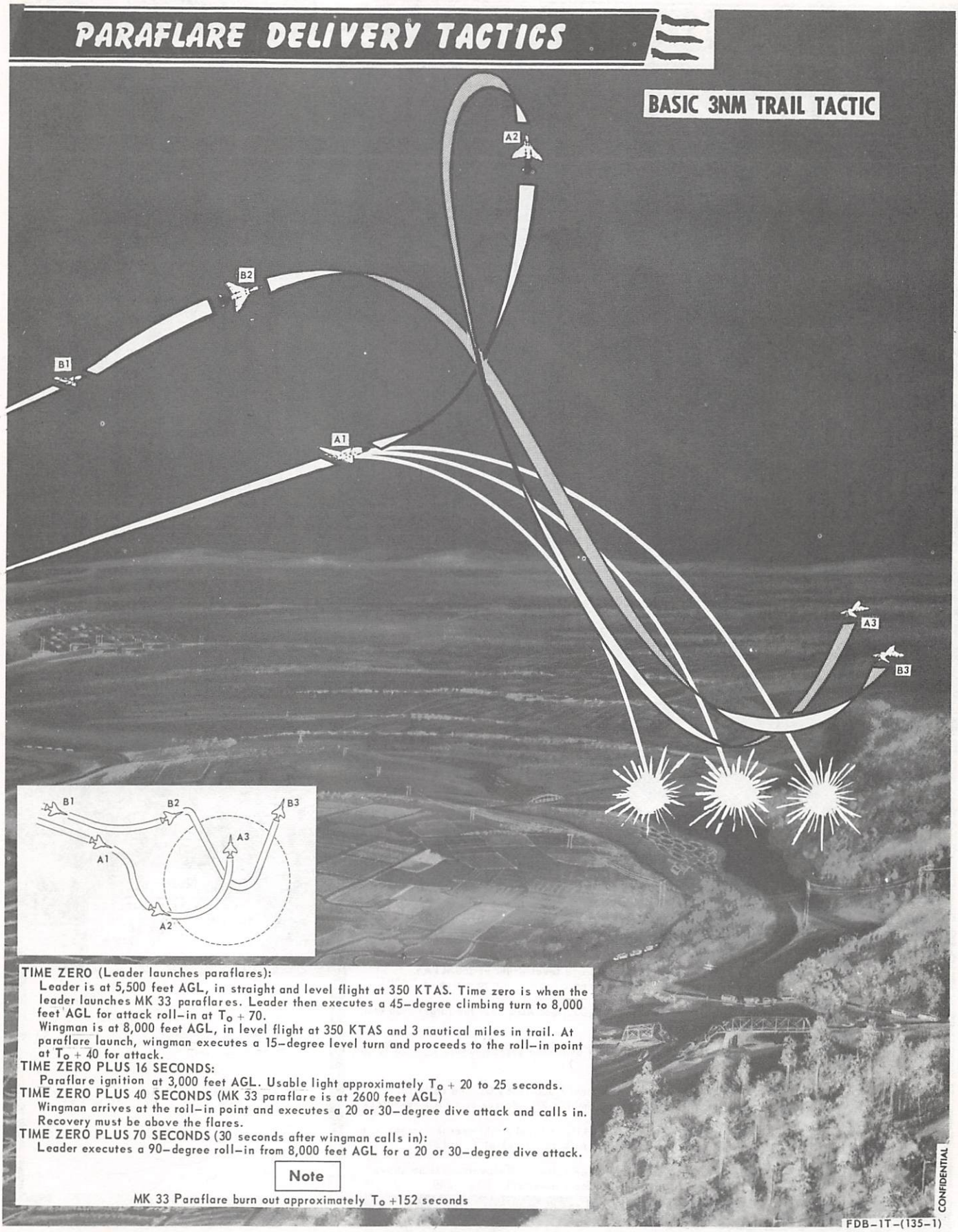


Figure 2-37 (C) (Sheet 1 of 4)

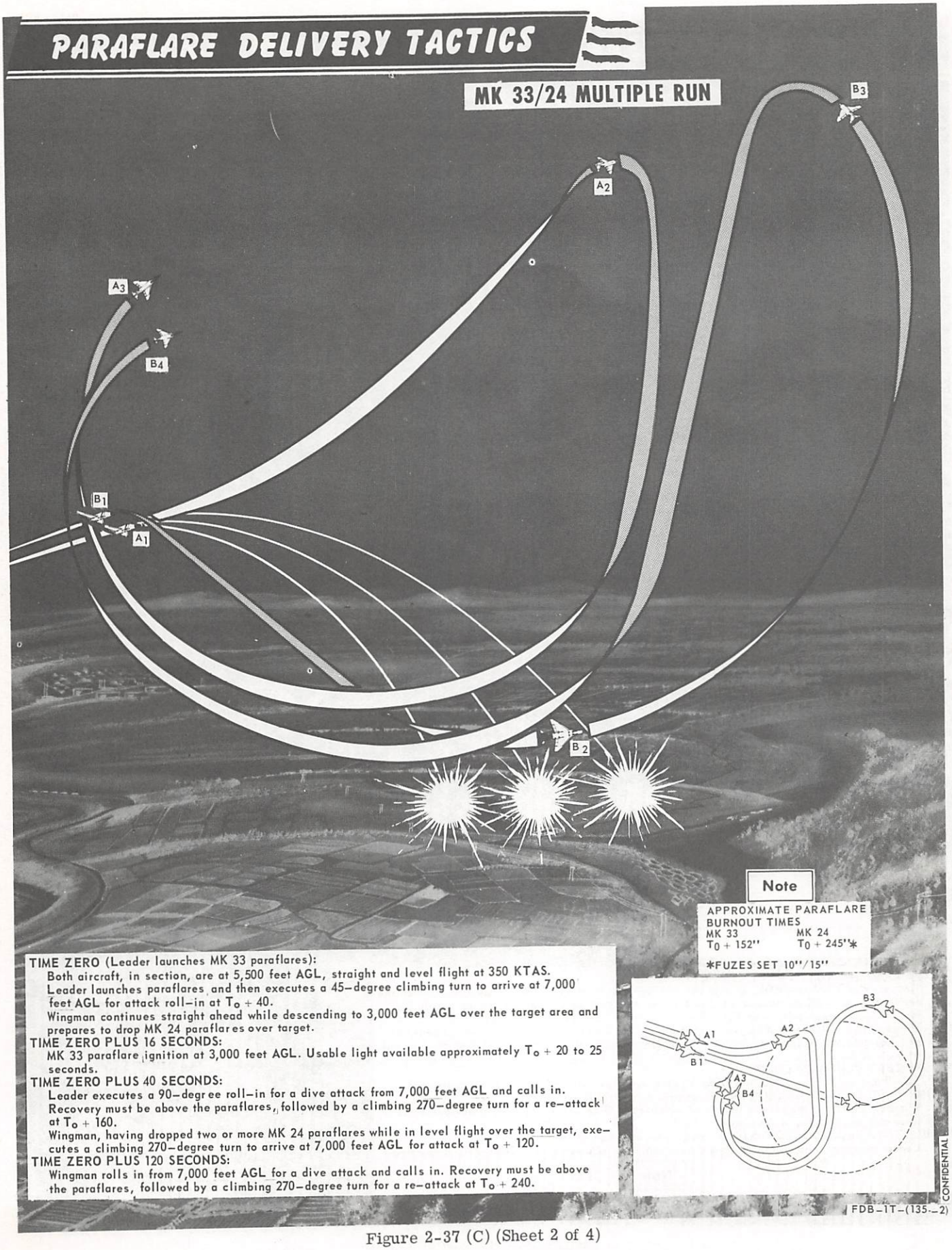


Figure 2-37 (C) (Sheet 2 of 4)

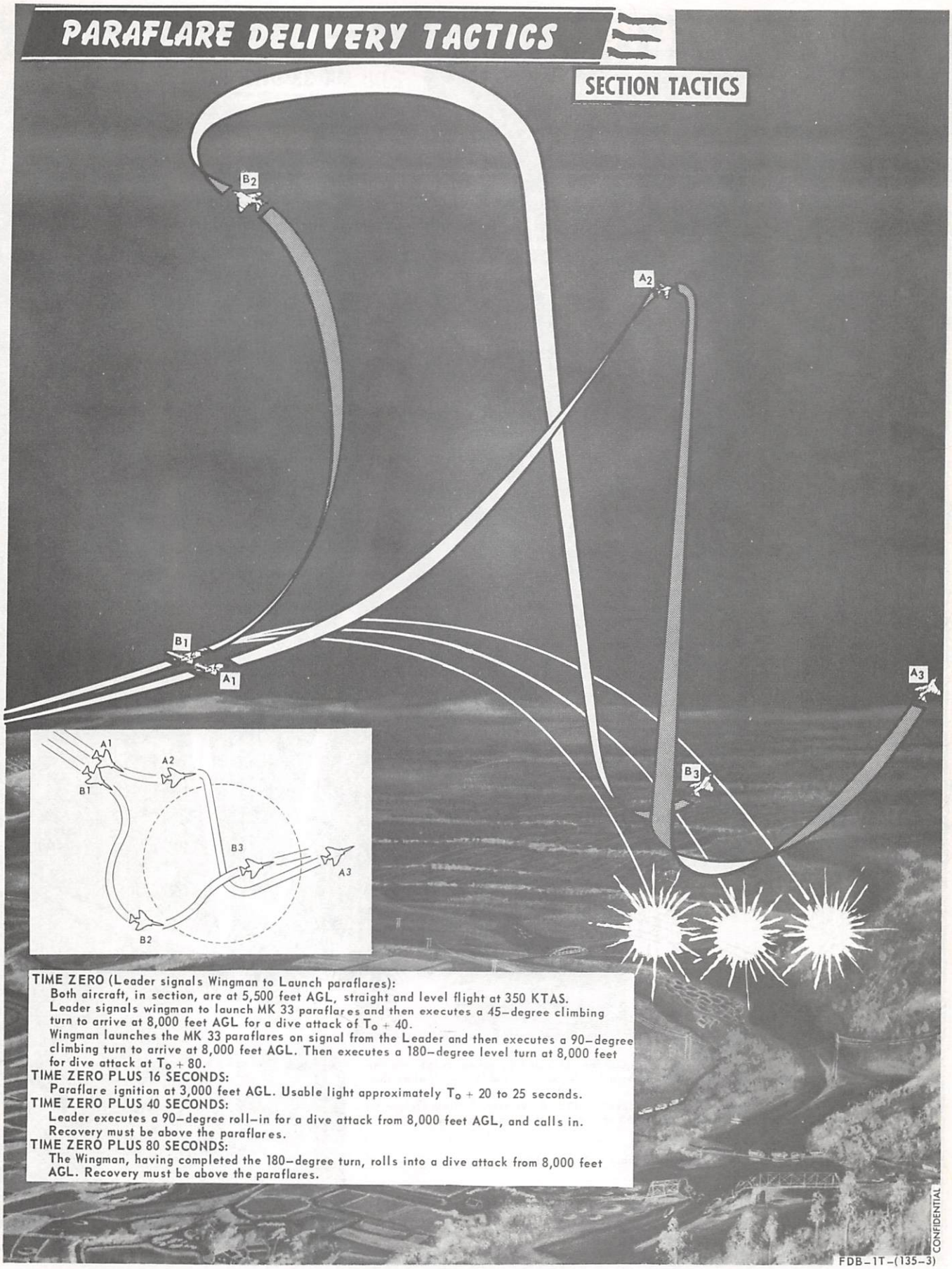


Figure 2-37 (C) (Sheet 3 of 4)

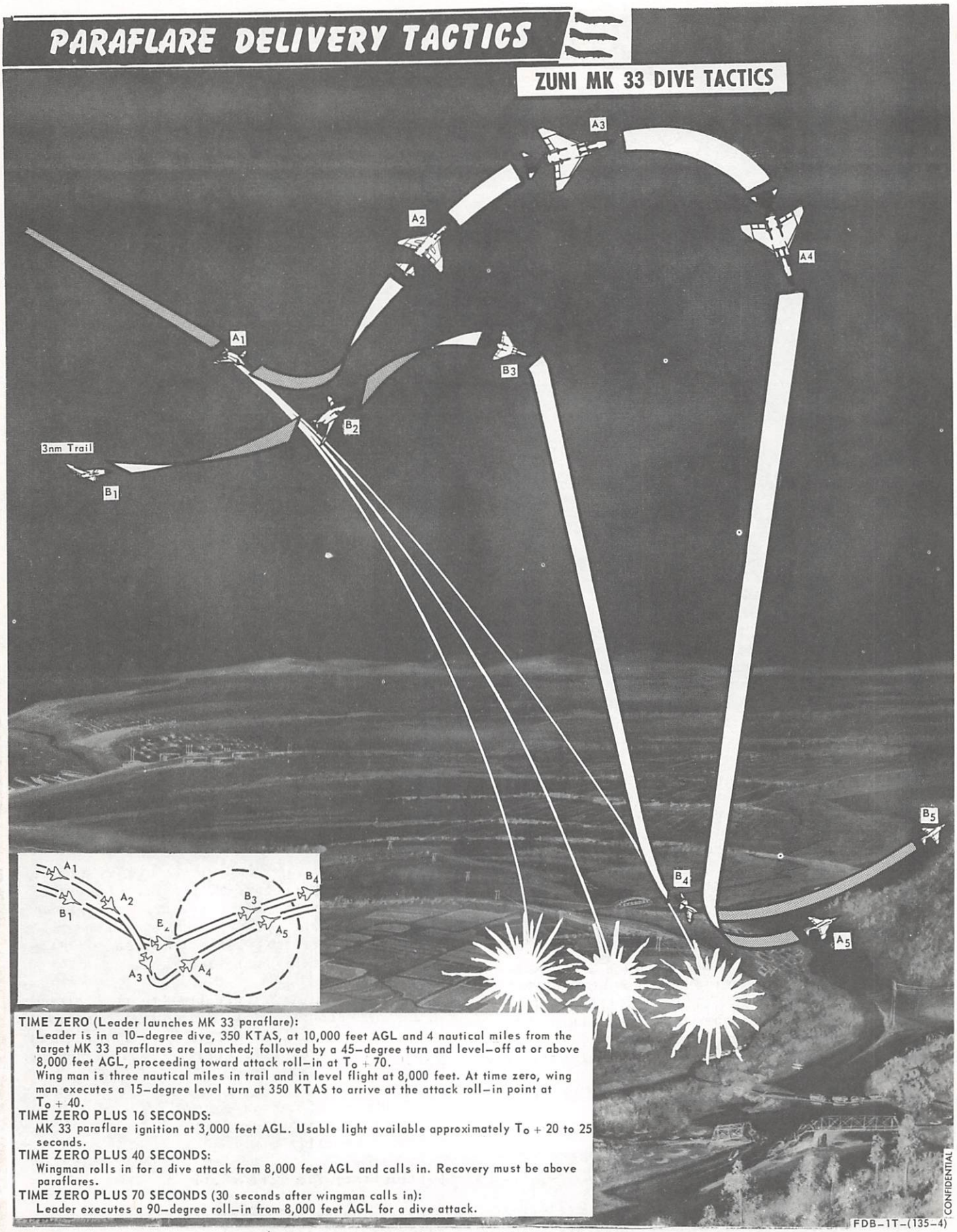


Figure 2-37 (C) (Sheet 4 of 4)

(C) Radar Considerations

1. The accuracy of MK 33 paraflare launch range is a function of the radar calibration. Prior to launch, on F-4B/N a check of BIT 1, 10 mile scale, on F-4J frame 163.00, profile 1, will give an estimate of 24,000 feet. Once airborne, at an altitude of 6000 feet AGL or higher, locking the altitude line in heavy clutter will present a correlation to the radar calibration.

Note

- F-4J, use Low Map mode and 10-mile range with fixed range strobe calibrated for 24,000 feet (4 radar miles) for accurate range when launching MK 33 paraflares.
- F-4B after AFC 532 and AFC 336 and F-4N, the radar has a bombing range strobe which can be calibrated for 24,000 feet (mode switch in BOMB).

2. Map mode and (F-4B/N normal clutter) or (F-4J LOW MAP mode) should be used to detect sea surface targets in excess of 10 miles when zero to moderate sea states exist. Once inside 10 miles with F-4B/N, the heavy clutter position should be selected.
3. Automatic lock should not be used because any sea state above zero will probably result in the lock on being lost.
4. Generally, a Map mode Search pattern offers the highest degree of accuracy and the least possibility of losing the target.

LASER MISSION

(U) LASER GUIDED BOMB SYSTEM

(U) GENERAL

(C) The laser guided bomb (LGB) system consists of a delivery aircraft, an airborne or ground laser target designator and kit munition unit (KMU) attached to a standard MK 82 high explosive bomb. The MK 82 kit can be used to make an extended wing (fin) or nonextended wing (fin) LGB (see wing assembly). The purpose of guided bombs is to improve the terminal accuracy of air-delivered munitions and to increase the stand-off range of delivery aircraft. Anticipated tactical applications are close air support, antiship missions, point target suppression, and interdiction. The LGB is capable of guiding to a target over a wide range of conditions, and can be released successfully up to 36,000 feet AGL. The LGB design is compatible with all current laser target designator equipment. No special avionics are required for LGB delivery. For a description of the Laser Guided Bomb Delivery Tactics, refer to (Secret) NAVAIR 01-245FDB-1T(A), section II.

(U) LASER THEORY

(U) Laser is an acronym for light amplification by stimulated emission of radiation. Some material, gas or solid, is used to amplify an external light source and thus emit higher intensity radiation. A neon flash tube is generally used as the light source. Emerald, ruby or neodynium (doped glass) rods are usually the materials that are excited. The energy is kept in the rod until the necessary level is reached. A pulse is then released.

(U) LASER BEAM PROPERTIES

(C) The emitted laser beam is coherent and collimated. This means the laser light waves are in phase at the same frequency and that the beams are parallel to infinity. These properties allow a laser to "spotlight" a target. The 1.06-micron laser frequency is in the infrared band and is invisible. Its ability to penetrate reduced visibility conditions is only slightly greater than the capability of visible light.

(U) LASER TARGET DESIGNATOR

(C) An airborne or ground based laser designator, with a wavelength of 1.06 microns and a pulse repetition of 10 pulses per second is used to illuminate the target. This is a standardized wavelength and pulse repetition frequency (PRF) for tactical designators. Tactical designator output energy is approximately 70 to 150 mj (millijoules). For a description of the various type of laser systems and laser designators, refer to (Secret) NAVAIR 01-245FDB-1T(A), section II.

(U) LASER GUIDED BOMBS

(U) The MK 82 Laser Guided Bomb is illustrated in part 4 which includes a physical description of the weapon, followed by the frag envelope and delivery ballistic data. The following is a function description of the weapon components as applied to the accomplishment of the laser mission.

(U) The KMU hardware is designed to mount directly to the bomb and convert the conventional munition into a terminal guidance weapon which is capable of guiding on reflected laser energy. Each kit contains three major components:

a. Guidance and Control Unit
b. Forward Adapter Assembly
c. Wing Assembly

(U) Guidance and Control Unit

(C) The guidance and control unit consists of three subassemblies: the laser illumination detector, bomb guidance computer, and bomb control section.

(C) The laser illumination detector consists of an infrared dome, optical bandpass filter, lens, quadrant detector, and associated electronics. The detector is aligned with the bomb velocity vector by a ring-tailed stabilizer. The seeker has a field-of-view of 12.5° (half cone) and a gimbal motion freedom of ± 18°.

(C) At release, two arming wires are extracted: one from the MK 344/376 electrical impact tail fuze, the other from the thermal battery firing assembly in the laser guided bomb control section. LGB guidance begins 3.5 seconds after release.

(C) The bomb guidance computer receives signals from the laser illumination detector through the associated electronics and processes these signals to provide control commands to the bomb control section.

(C) The bomb control section consists of a thermal battery, gas grain generator assembly and four movable canard control surfaces. A one-shot thermal battery with a 70-second life ignites a gas grain generator 3.5 seconds after release. The 3.5-second delay allows the aircraft sufficient time to clear the LGB in case of a guidance command malfunction. When ignited, the gas grain generator produces high pressure gas which is used to move the canards. The canards are controlled in a "band-bang" manner and streamline if guidance is lost. The movable canard control surfaces are attached to the bomb control canard shafts by means of cam locks to enable quick attachment and removal. MK 82 LGB canards are supplied in the extended form and have a "knock-off" feature for adaptation to the LGB nonextended version.

(U) Forward Adapter Assembly

(U) The forward adapter assembly is used as an interface between the guidance and control unit and the nose of the bomb.

(U) Wing Assembly

(U) The wing assembly is a rigid one-piece assembly which mounts on the aft end of the bomb body, replacing the tail assembly of the conventional bomb. It provides both weapon aerodynamic stability and the lift necessary for inflight maneuvering. The wings are provided in the nonextended form (high speed) and have bolt-on extenders for the extended version (low speed).

CAUTION

Do not use the high-speed wings (non-extended) for low-speed delivery. The low-speed wings (bolt-on extenders) may be used for both high-speed and low-speed deliveries. Refer to External Stores Limitations, Appendix A.

(U) LASER MISSION CONSIDERATIONS

WARNING

Tactical lasers can cause eye damage. The eyes can be damaged if they are exposed to sufficient laser energy focused on the retina. The hazard is greater at night when the eye is night adapted. For detailed information refer to P-5052-35. Diffused reflected energy should not be viewed within 2,000 feet (day) or 5,000 feet (night) unless protective glasses are worn. Protective glasses must be worn if a tactical laser is directly viewed inside 10 to 15 nautical miles.

(U) LASER GUIDED BOMB DELIVERY TACTICS

(U) Refer to (Secret) NAVAIR 01-245FDB-1T(A), section II, for a description of day and night delivery tactics and general level delivery tactics.

(U) LASER TARGET DESIGNATOR SYSTEMS

(U) Refer to (Secret) NAVAIR 01-245FDB-1T(A), section II, for a description of ground and airborne lasers, the various laser designator systems, and for both designator and delivery tactics.

(U) TARGET DESIGNATION CONSIDERATIONS

(C) The LGB must "see" sufficient reflected laser energy to guide to the target. Different surfaces reflect energy in a different manner. A mirror-like surface will reflect energy similar to the way a mirror reflects a light beam. An irregular surface reflects energy in a diffused manner. Water seems to absorb laser energy. Most tactical targets will have an irregular surface. Indications are that for an irregular surface, the highest level of reflected energy is in the direction from which the beam was transmitted. Therefore, maximum LGB acquisition range occurs when the bomb flight path and laser line-of-sight are coincident in the horizontal plane. This is a zero-aspect angle attack and is considered the optimum attack heading. A target with a vertical surface will reflect minimum energy to the LGB if the laser and bomb are on opposite sides of the target. Similarly, an obstruction between the laser and target will interrupt the required energy. These considerations make it mandatory that the laser operator consider terrain and type target as well as existing visibility.

(U) DELIVERY CONSIDERATIONS

(C) Either a ground or airborne laser can be used to illuminate the target. The LGB is dropped so that it has the capability to "see" and to fly to the target. The release conditions which are within the guidance capability of the weapon to hit the target is defined by a delivery basket or envelope. The basket is a

(C) function of time-of-fall (TOF), altitude, airspeed, dive angle, horizontal range to the target and acquisition range. Basket width is approximately 2/3 of basket length. Figure 2-38 contains a profile view and a top view of LGB release geometry.

(C) Basket considerations are:

a. Minimum TOF is 8.5 seconds: 3.5 seconds for the bomb to initiate guidance and 5 seconds of guidance time.
b. Altitude and airpseed must be such that the bomb has 8.5 seconds TOF and has the kinetic energy to maneuver to the target.
c. Flight path angle of the bomb must be such that the target will fall within the seeker field-of-view after guidance initiation.
d. Horizontal distance from the target must be such that the bomb can fly to the target using its kinetic energy. This applies to azimuth and range (both long and short) corrections.
e. Acquisition range is affected by flightpath angle, visibility, laser power and target reflectivity; and in turn affects guidance time. A 12,000-foot maximum acquisition range was assumed during delivery data development.

(U) Dive Delivery

(U) Centroid, Optimum and Ballistic release conditions and sight angle settings are contained in section II, part 4. The sight angle settings are calculated to give a release between basket center and the Ballistic release point. This optimum release condition provides the best trade-off between basket size and bombing accuracy and should be used whenever possible. A 550 KTAS, 45° dive release is recommended for the high-speed wing configuration.

(C) Roll in should be made 6000 to 8000 feet above release altitude at 400 KTAS. With high drag count configurations, or if ceilings prohibit a high altitude roll in, an increase in roll in airspeed should produce the correct delivery airspeed.

(C) The target should be tracked in a normal manner. A common tendency to induce aiming error due to G by pushing over as the airspeed increases can be prevented by pre-trimming the aircraft for the release airspeed. A correction of 6 feet per knot of release wind is recommended for wind compensation during the 3.5-second ballistic time of flight. The laser operator will compensate for wind during guided flight.

(U) No attempt should be made to adjust the release point for errors in planned release conditions; if parameters are not met, the run should be aborted. Never release low, slow, or shallow. A steep, fast or high release is preferred if a precision release is not possible.

(U) Level Delivery

(C) Level deliveries of the MK 82 extended wing LGB are feasible if an accurate delivery mode is available. Level delivery of the MK 82 nonextended (high speed only) LGB is not recommended because the delivery basket has not been adequately defined. Based on guidance considerations, the recommended MK 82 extended wing LGB release conditions are:

a. Optimum - 8000 feet AGL/450 KTAS
b. Minimum practical - 4000 feet AGL/450 KTAS

(U) Prior to takeoff, the aircrew should visually check seeker condition and arming wire routing. The LGB will not guide if the arming wire through the thermal battery firing device is extracted in flight prior to release, or is not installed prior to takeoff, or is not extracted when the weapon is released. Refer to the Tactical Manual Pocket Guide (Unclassified) NAVAIR 01-245FDB-1T(B) for weapon exterior checks.

CAUTION

Avoid prolonged flight through clouds, if possible. Seeker can be damaged during flight through moderate rain.

(U) If guidance problems are experienced, it is recommended that a check be made with the laser operator to confirm laser output and boresight. Specific employment tactics and combat accuracy are classified SECRET. Comments about lasers and LGB's must be avoided during radio transmissions.

MK 82 LASER GUIDED BOMB MISSION

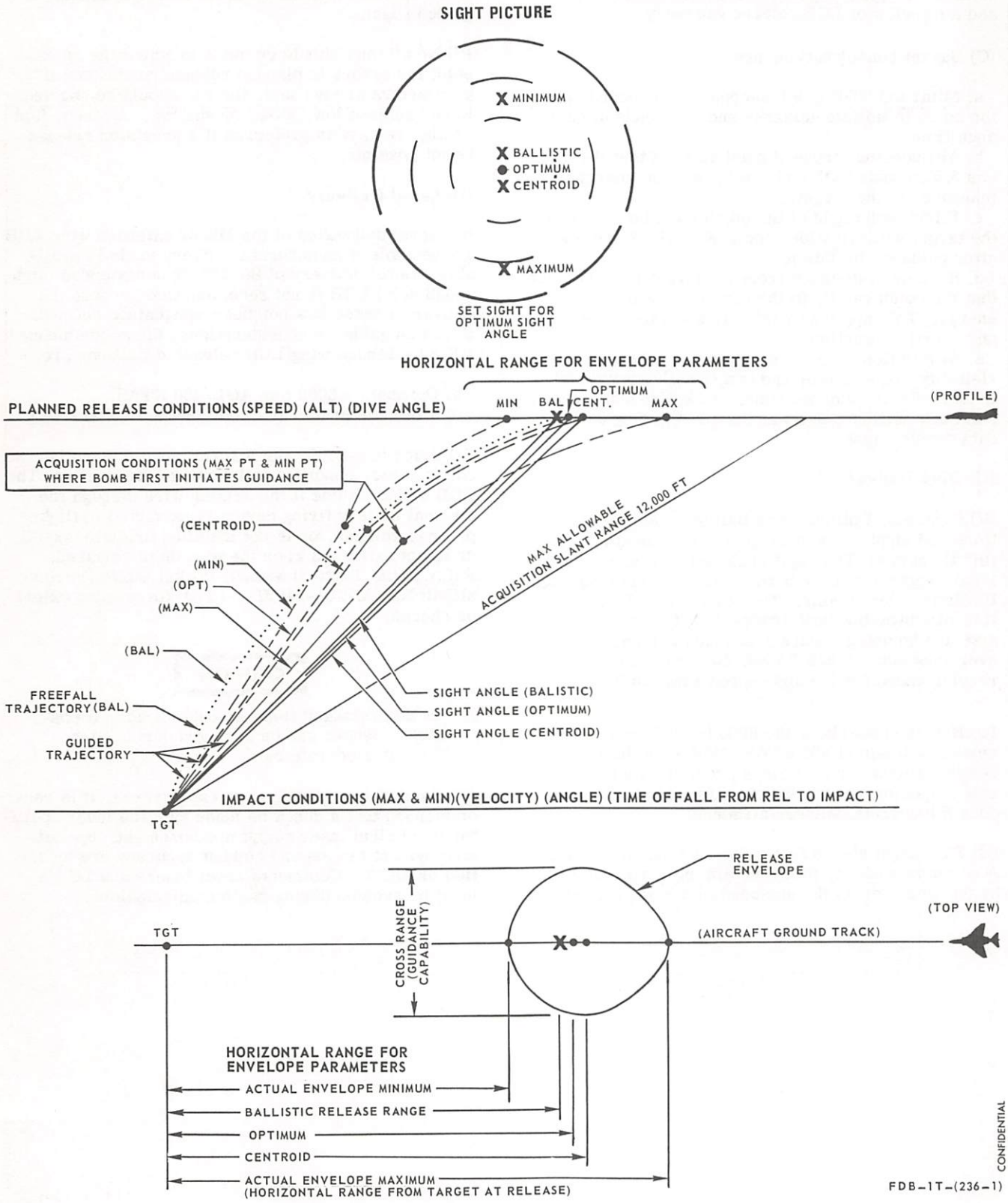
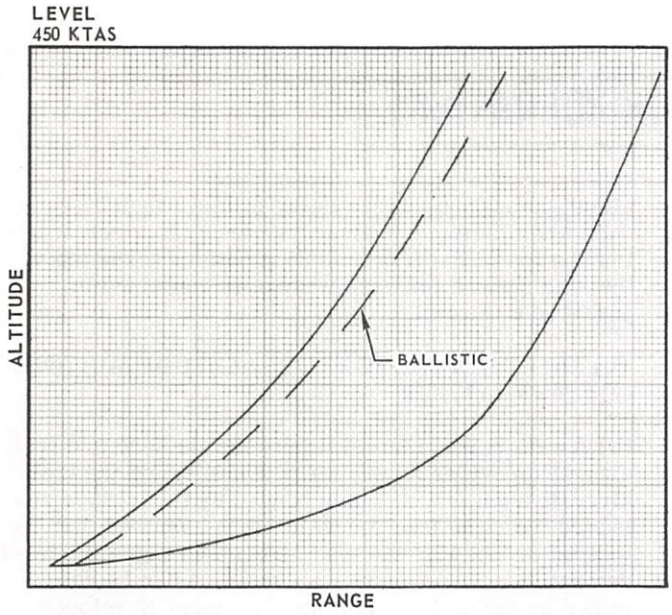


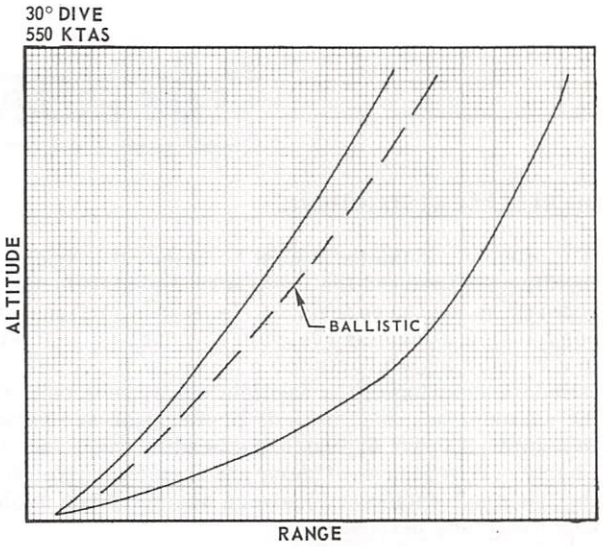
Figure 2-38 (C) (Sheet 1 of 2)

MK 82 LASER GUIDED BOMB MISSION-CONTINUED

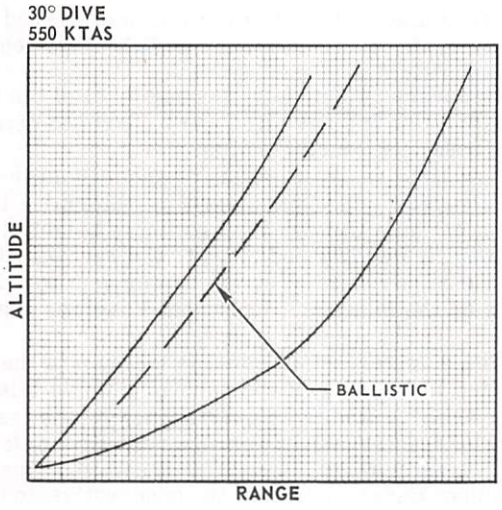
TYPICAL LGB ENVELOPES

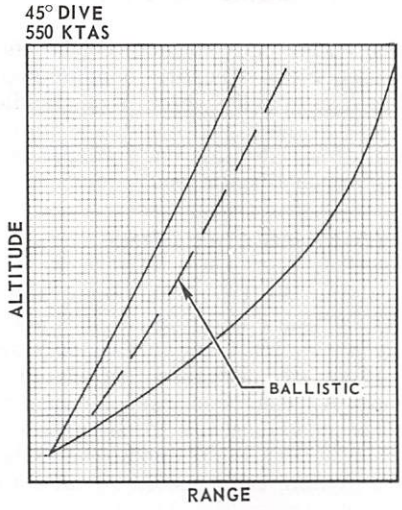
EXTENDED FIN





NON-EXTENDED FIN





CONFIDENTIAL

FDB-1T-(236-2)

Figure 2-38 (C) (Sheet 2 of 2)

PART 3 DELIVERY MANEUVERS

NOTICE

Even though portions of Part 3 may be applicable to both F-4B/N and F-4J aircraft, only the F-4B/N aircraft is presently considered.

SAFE ESCAPE CONSIDERATIONS

(U) RELEASE RESTRICTIONS

(U) Release parameters must be selected to enable the aircraft to avoid the weapon fragmentation and to recover above the terrain. Release restrictions to ensure safe escape and terrain avoidance are given in the sight angle charts for each weapon. A detailed description of the application of these data and the assumptions used in their preparation are given in section II, part 4, under the heading Sight Angle Charts. Thorough consideration should be given to the trade-off necessary between accuracy and avoidance of enemy defenses.

(U) FUZING

(U) Refer to Minimum Authorized Arming Times and Speeds, figure 2-10.

(U) AIRCRAFT-TO-BOMB COLLISIONS

(U) Tracking during release must not be such as to reduce the prescribed aircraft-to-bomb separation. The component of gravity which is perpendicular to the flight path of the aircraft must be lower than the release limitation listed for each weapon in appendix A, External Stores Limitations.

(U) BOMB-TO-BOMB COLLISIONS

(U) Bomb-to-bomb collisions can occur and have occurred under certain combinations of release interval and weapon ejection angles. Proper planning and pre-flight caution can decrease this occurrence. Refer to appendix A. Retarded weapons such as Snakeye have a great tendency toward bomb-to-bomb collision caused by an aerodynamic phenomenon called tailgating. Fuze arming time should be carefully selected to provide maximum aircraft-weapon separation prior to arming. Refer to Minimum Authorized Arming Times and Speeds, figure 2-10. Refer to Bomb Spacing During Multiple Release Charts description, part 4.

(U) COORDINATED ATTACKS

(U) During attacks on a target complex in which more than one aircraft are involved, careful consideration must be given to flying through fragmentation of weapons released from other aircraft. A general rule of thumb is to follow the first aircraft on the target simultaneously or with a delay of more than 30 seconds when delivery maneuvers carry the aircraft below the top of the fragmentation pattern. The top of the frag pattern for each weapon is contained in part 4 of this section.

(U) SAFE INTERVAL FOR LOW ALTITUDE MULTIPLE AIRCRAFT ATTACK

NEW

(U) A safe release interval between the lead and trail aircraft provides a zero hit probability for the trail aircraft from fragments produced by the weapon released from the lead aircraft. It is assumed that the weapon dropped by the lead aircraft is a ground-level detonation. The safe release interval can be determined by using the Maximum Fragment Envelopes presented in part 4 for each weapon. To determine the safe release interval between the lead and trail aircraft, the following factors must be known:

NEW

a. The time of flight of the weapon delivered by the lead aircraft, obtained from the Sight Angle charts, or Pocket Guide.
b. Recovery height above ground level of the trail aircraft. Use the Dive Recovery charts to determine the altitude lost during pullup.
c. The time of flight of the fragment from the weapon delivered by the lead aircraft. Determine the time from bust through the maximum height of the fragment trajectory and down to the recovery height of the trail aircraft. Use the center vertical time curve on the Maximum Fragment Envelope chart.

(U) The safe release interval is the sum of the values obtained in a and c. If the recovery height b is greater than the maximum height obtained by the fragment, any release interval between aircraft will be safe. The safe release interval determined from the Maximum Fragment Envelope charts is conservative and is applicable for all dive angles and varying release conditions between the lead and trail aircraft. For rockets, special consideration is given to dive angle. Maximum Fragment Envelope charts are provided for various dive angles. Refer to part 4.

(U) A more realistic safe release interval, one that is less conservative, is illustrated for the MK 82 and 83 LDGP Bombs in figure 2-40. The safe release interval is presented as a function of the release height of the trail aircraft and assumes that the lead aircraft releases at the 0.000 fragment hit release height (or higher) stated in the Sight Angle chart.

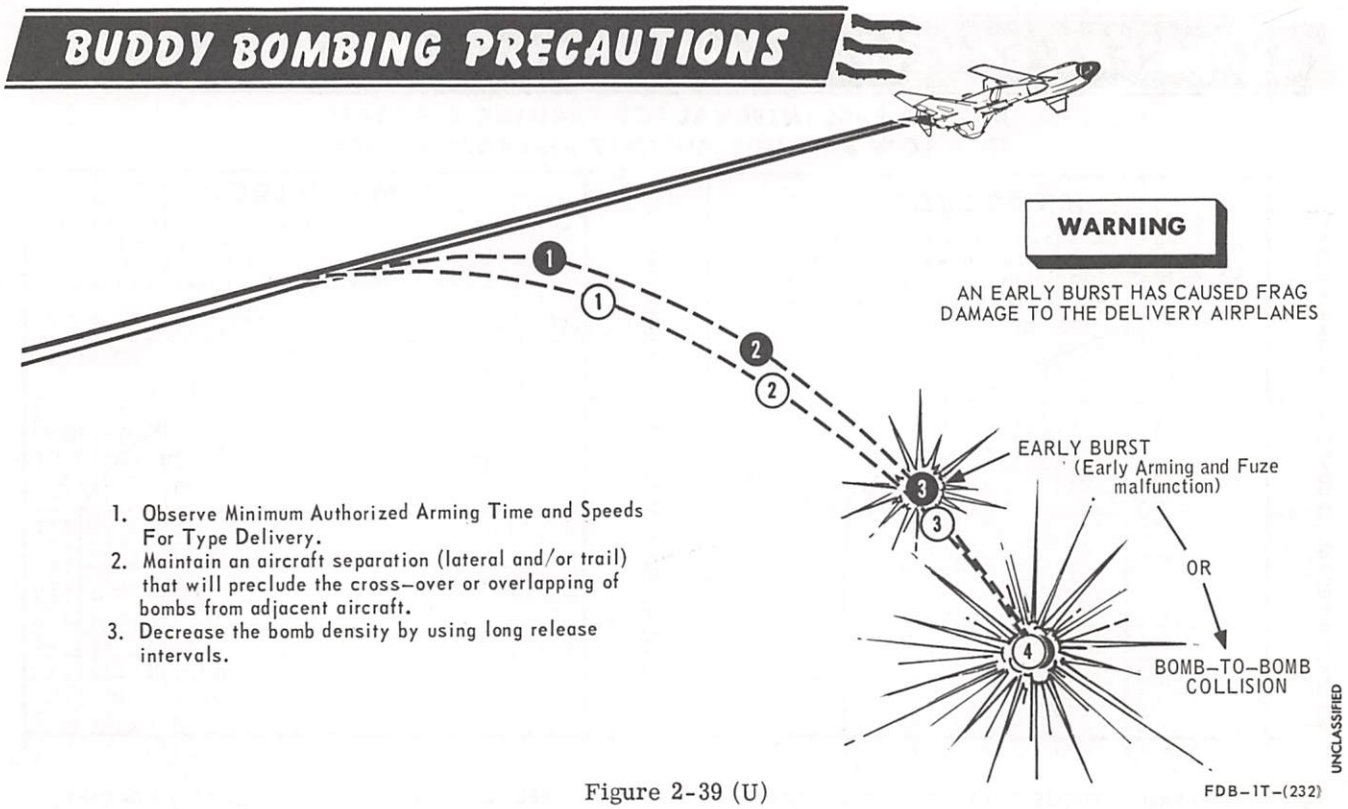


Figure 2-39 (U)

These two charts are valid only when the lead and trail aircraft have the same attack heading and are releasing the indicated weapon in level flight and at the stated airspeed. Obviously, a large number of charts would be required to present safe release interval as illustrated in figure 2-40 for all possible release conditions. Figure 2-40 also illustrates a typical aircraft flight path superimposed over a fragment envelope resulting from the release conditions given on the chart. The minimum release height presented in the Sight Angle charts and Pocket Guide are determined by this method.

(U) BUDDY BOMBING

WARNING

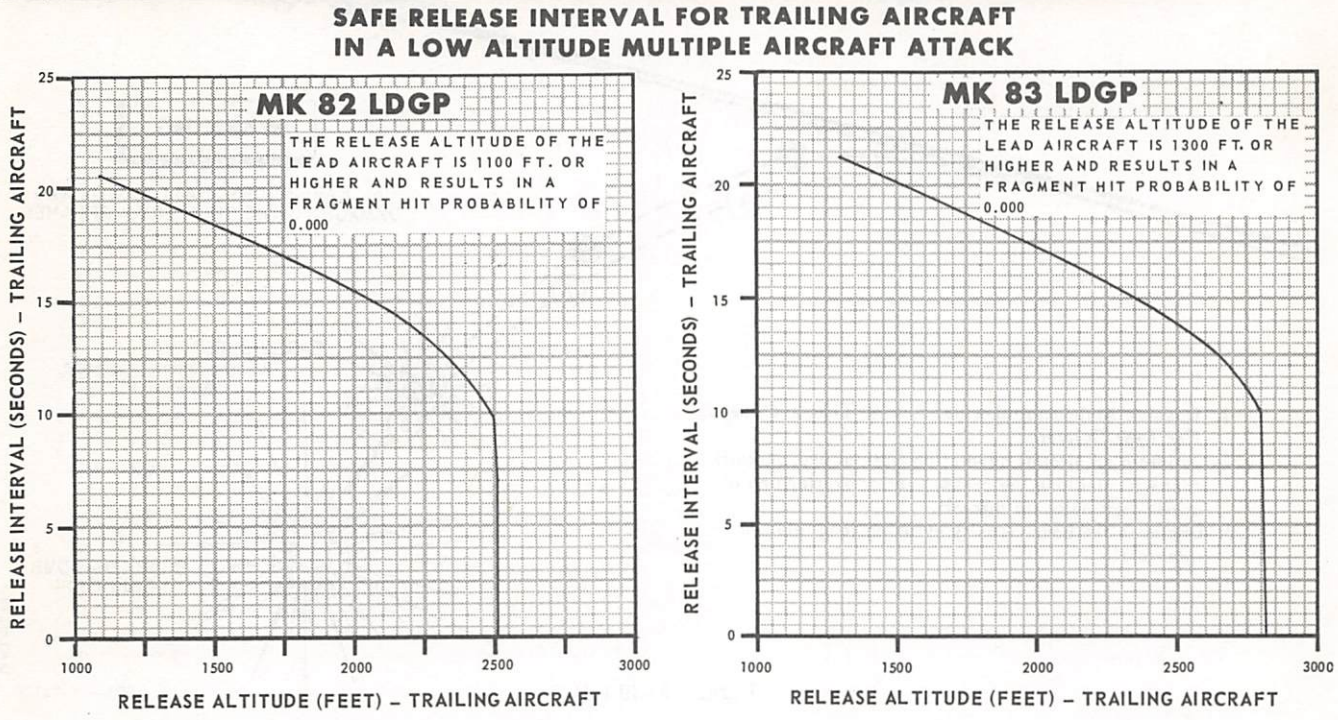
The minimum authorized arming times and speeds must be observed and followed for each type of delivery as depicted in figure 2-10. It is paramount that the crews of all aircraft be aware of the probabilities of fragment hit in the event of early burst when the arming time is less than the minimum authorized arming time prescribed for the delivery maneuver. This could conceivably occur when a dive delivery mission is diverted to a level delivery mission.

(U) Early bursts while buddy bombing, combat sky spot, and other level delivery maneuvers inherently increase the danger of fragmentation damage to the delivery aircraft. Early burst can result from bomb-to-bomb collision after the fuze has armed and/or fuze malfunction and detonation at the end of the preset arm time. The probability of bomb-to-bomb collision is greater in a multiple aircraft release with aircraft in close proximity to one another and with reduced aircraft intervalometer settings. With release conditions such as these, fuze arming time becomes critical to provide adequate bomb-to-aircraft separation before the fuze arms. Aircrews must be aware of the minimum authorized arming time for the mode of delivery utilized. Violation of the minimum authorized fuze arming time typically occurs during divert missions where the pre-planned delivery was dive bombing and the aircraft were diverted to combat sky spot, buddy bombing, etc. Aircrews should observe the following precautions to increase their margin of safety when performing combat sky spot, buddy bombing, and other level deliveries:

a. Observe minimum authorized arming time and speeds for type delivery.
b. Maintain the maximum possible lateral and/or nose-to-tail (Trail) aircraft separation within the confines of operational requirements. Minimum time intervals between aircraft in level deliveries are presented in figure 2-40 (sheet 2), Safe Interval For High Altitude Multiple Aircraft Attack.
c. Decrease the bomb density by using long release intervals.
d. Execute a positive, break-away maneuver as soon after release as possible.

(U) Some of these precautions are illustrated in figure 2-39. For minimum aircraft separation consideration in dive and level deliveries, assuming a ground detonation, refer to Safe Interval for Low Altitude Multiple Aircraft Attack.

FRAGMENT ENVELOPE/SAFE RELEASE INTERVAL



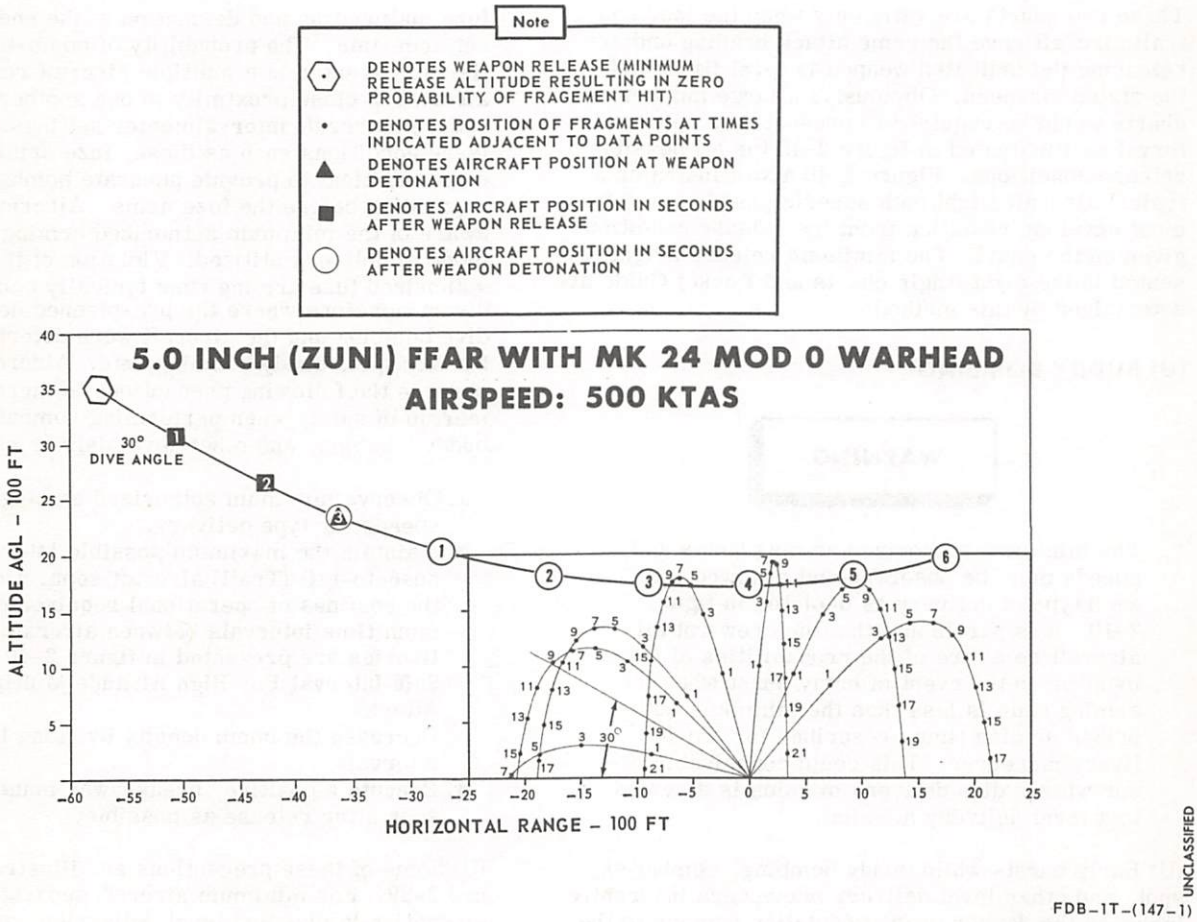
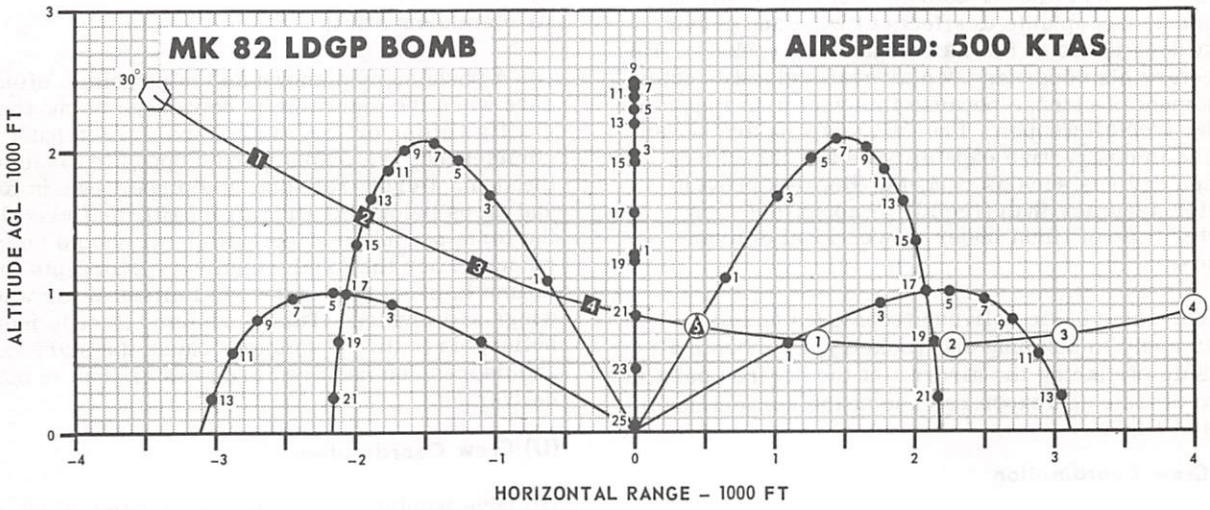


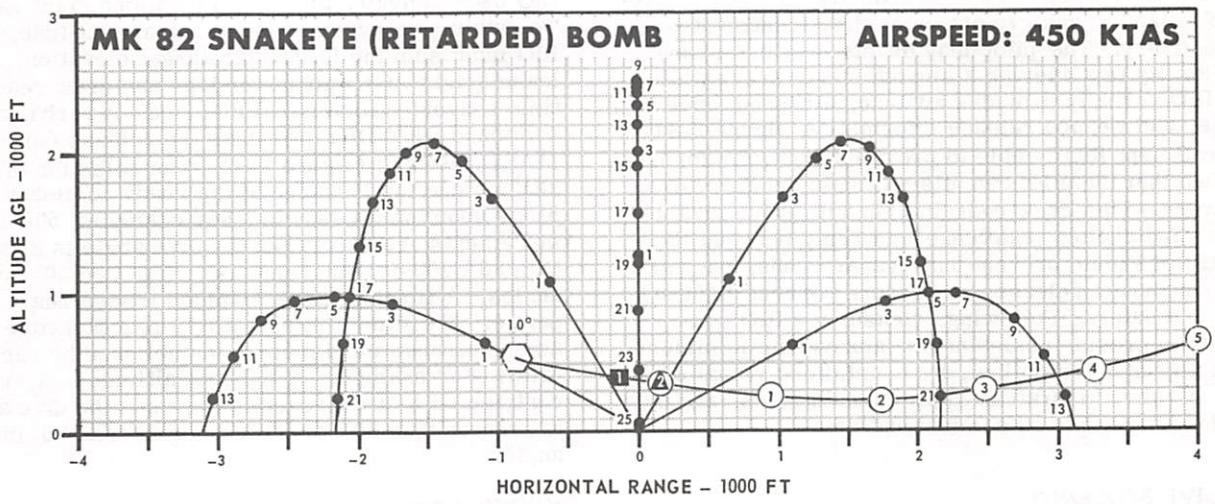
Figure 2-40 (U) (Sheet 1 of 2)

FRAGMENT ENVELOPE/SAFE RELEASE INTERVAL (CONTINUED)

Note

- DENOTES WEAPON RELEASE (MINIMUM RELEASE ALTITUDE RESULTING IN ZERO PROBABILITY OF FRAGMENT HIT).
- DENOTES POSITION OF FRAGMENTS AT TIMES INDICATED ADJACENT TO DATA POINTS
- DENOTES AIRCRAFT POSITION AT WEAPON DETONATION
- DENOTES AIRCRAFT POSITION IN SECONDS AFTER WEAPON RELEASE
- DENOTES AIRCRAFT POSITION IN SECONDS AFTER WEAPON DETONATION





SAFE INTERVAL FOR HIGH ALTITUDE MULTIPLE AIRCRAFT ATTACK

Release Altitudes	Minimum Safe Interval* (Sec) Between Lead and Trail Aircraft for Level Release of the Mark 80 series bombs fuzed at:	
	6.0 sec	10.0 sec
5000 to 15,000	30	25
15,000 to 25,000	35	30

*a safe release interval between the lead and trail aircraft is defined as an interval which provides the trail aircraft zero hit probability from early burst of weapons released by the lead aircraft.

UNCLASSIFIED
FDB-1T-(147-2)

Figure 2-40 (U) (Sheet 2 of 2)

BOMBING/ROCKETRY

(U) GENERAL

(U) Bombing is the basic method of air delivered weaponry against enemy surface targets. The classical dive delivery and level delivery maneuvers include the delivery of retarded and unretarded bombs, fire bombs, and cluster bombs. Freefall weapons are more susceptable to effects of wind and gravity due to long times of fall as compared to rockets. The trajectory also depends upon aircraft velocity vector at moment of release because this vector is imparted to the freefall weapon. Freefall weapons are not as limited in destructive capability as are thrust augmented devices such as rockets. Rockets provide greater accuracy than freefall weapons due to a shorter time of flight under conventional delivery tactics.

(U) The same basic delivery techniques and procedures apply to bombing and rocketry, i.e., basic airmanship of placing the aircraft at the desired point in space at time of weapon release at the correct conditions of flight.

(U) Crew Coordination

(U) The advantage of crew coordination cannot be over emphasized to achieve optimum effectiveness of weapon delivery. The pilot may devote maximum time and ability to achieving a smooth steady track while the RIO verbally provides altitude, airspeed, dive angle, and weapon release information (figure 2-41). A proficient RIO is able to provide accurate information so that the pilot can attain utmost accuracy of delivery. This crew coordination will prove invaluable. Switchology challenge and reply between RIO and Pilot should prevent unnecessary runs, inadvertent/incorrect releases and ensure correct sight setting and safety. Following release, the RIO continues to provide assistance by announcing minimum safe altitudes for pullout, by maintaining visual contact of other aircraft in multi-plane strikes, and by performing required communications.

(U) DIVE BOMBING

(U) Dive bombing is the accepted delivery method of conventional ordnance against a surface target. Weapon arming time, terrain and enemy defenses, and safe escape distances must be considered. The dive delivery is used (1) against targets which cannot be attacked at low level due to terrain limitations, and (2) against entrenched, revetted or screened targets which must be approached from above. Dive angles from 10° to 45° are best suited after consideration of all factors, such as: aircraft performance, target acquisition, escape maneuvers, etc.

(U) A crew in combat does not have the advantage of familiar landmarks which could be used to determine release slant range and dive angle. Therefore, proper position is based upon estimated range and altitude. Since dive angle is extremely critical in dive deliveries, a base leg can be an invaluable aid to arriving at the planned dive angle. Two commonly used methods are (1) a pop-up to base from low altitude or (2) a high altitude and/or high G race track pattern, depending upon enemy defenses.

(U) Pendulum Effect

(U) A phenomenom known as the pendulum effect occurs when the sight line is depressed below the aircraft's rolling or longitudinal axis. As a bank is commenced, the pipper moves opposite direction of the turn. During roll-out, the pipper swings back and stops below the aircraft longitudinal axis; hence, the term pendulum effect. Roll-out should be commenced when the longitudinal axis intercepts the run-in line to preclude a horizontal offset error when wings are leveled. This pendulum effect is more noticeable in dive bombing because the slant range and depression required are greater than in other deliveries.

(U) Crew Coordination

(U) Dive bombing is a crew coordinated effort. The RIO uses indicated altitude to establish slant range. To establish a precise verbal release altitude, the RIO must sum the following: target elevation, release height AGL, altimeter lag, and crew reaction time converted to vertical distance. A verbal ready command STANDBY precedes the release command MARK. Refer to figure 2-41. The selection of the altitude cue for issuance of the ready command depends upon the dive angle. For example: 500-foot increments are used when the dive angle is greater than 30°; 200-foot increments for 20° and 30° dive angles. Altimeter lag is obtained from a chart in part 4. The sum of pilot and RIO reaction time varies among aircrews and must be established by each crew. For example: a 100-foot altitude lost may be contributed to crew reaction lag when the dive angle is greater than 30°; or 50 feet for 20° and 30° dive angles.

(U) Wind Effect

(U) Wind presents the pilot with the greatest variable in delivery. The weapons must be delivered from a wings-level, balanced flight condition, because gross errors result when the aircraft is banking or skidding during the release. The problem is further complicated when attempting to conjure an offset aim point to compensate for the wind. If wind is unknown, assume zero wind for first run and attempt to achieve precise release delivery conditions. Only then can an estimate of wind effect be determined by observing the impact. Compensation for wind effect on successive runs is then possible. A 30-second interval between aircraft in a flight is advantageous, for the second aircraft can observe the leaders impact and adjust. A common tendency is to yaw the aircraft to maintain track during crosswind conditions: this yaw

input produces undesireable results. The drift method of correction is best suited for dive bombing because a wings level condition is maintained throughout the attack run. Moving targets present essentially the same problem as wind, hence, corrections are similar. Refer to Wind Effects During Tracking.

(U) Summary

(U) Consideration should be given to making one run, releasing all similar ordnance on the target to optimize hit probability. Attempting to "place the apple in the barrel" is much less effective than "surrounding the barrel with apples". One consideration usually omitted in weaponry is ballistic dispersion. If all release conditions were ideal, weapon ballistic dispersion alone may cause a miss. Error analysis during the attack run can only be accomplished by the more experienced crew. Refer to Tactical Manual Pocket Guide for Error Sensitivity Summary and to section II part 4 for the particular weapon error sensitivities.

DIVE DELIVERY CONSIDERATIONS

(U) GENERAL

(U) The dive delivery is illustrated in figure 2-41. When determined that a dive delivery will be employed, the following should be accomplished:

a. Depress the optical sight to the proper sight angle.
b. Set the gyro horizon at the release airspeed and center the ball.
c. Note the release altitude.
d. Review crew terminology.
e. Review switchology.
f. Pre-trim the aircraft at roll-in for release airspeed (approximately 2.5 units nose down).

(U) ENTRY

(U) The entry position is obtained by one of several entry maneuvers, all of which may embrace jinking: the low-altitude pop-up entry, the level entry, and the high altitude dive or spiral entry. The entry maneuver enables the pilot to position the aircraft on the desired dive path at a distance from the release point that will provide adequate time to perform the corrections required to achieve planned release conditions. Lack of current pilot experience or adherence to a previously established training regimen may result in a prolonged time-of-flight from entry to release necessary to accomplish target acquisition and a pipper control technique. Combat entry parameters, however, are dictated by required release conditions which are determined by assessment of target/weapon/enemy defense relationship. The time required in the dive will be determined by the weather or cloud cover and the enemy defenses. The optimum time from entry to release for various defensive environments is provided in the secret supplement to this manual.

NEW

Note

The pilot should be aware that the AJB-3 precesses in pitch during high G loads.

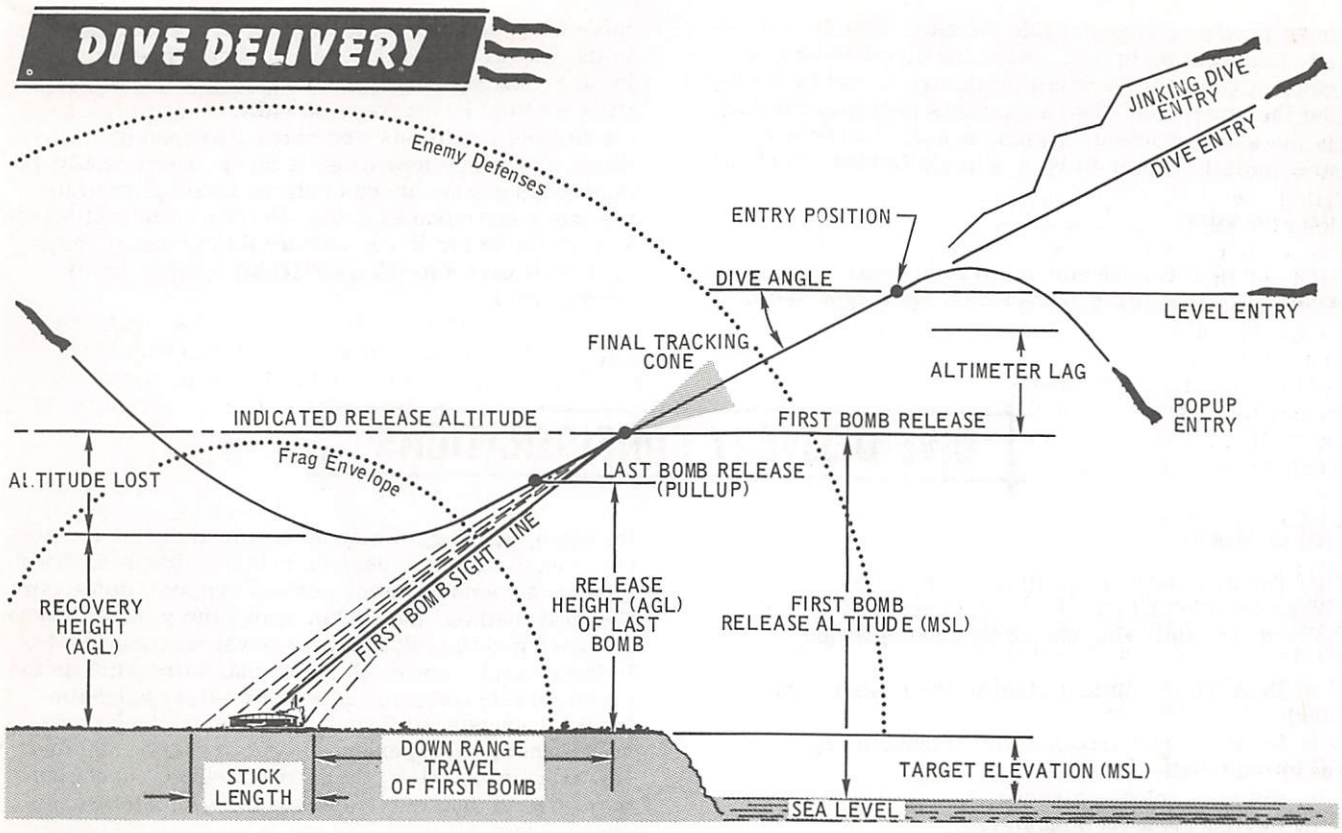
(U) Generally, MRT (Military Rated Thrust) will be used throughout the pattern. Under high gross weight conditions, CRT (Combat Rated Thrust) may be required to maintain airspeeds above 250 KTAS at roll-in. Also, IDLE rpm may be required during the attack run to maintain desired release airspeed. Two typical methods of power control are as follows. In the first method, the RIO provides the pilot with true airspeed and the pilot adjusts power to compensate. In the second method, the pilot maintains MRT in the dive until release airspeed is achieved, at which time the RIO requests IDLE rpm. The first method is best suited when pilot experience in the aircraft is high and RIO experience is low, the second method is best when the converse is true. (Refer to Dive Acceleration charts, part 4.)

(U) Maneuvering energy is sharply reduced below airspeeds of 300 KCAS and caution must be exercised when executing a high G roll-in. The roll-in technique should be varied to compensate for errors in down range distance. If the downrange distance appears excessive, initiate a level turn, allowing the nose to fall through as attack heading is approached. If the downrange distance appears minimal, initiate a nose low turn to obtain the desired dive angle. The nose level method dissipates more energy, and airspeed buildup must be faster to arrive at optimum release parameters.

NEW

(U) Pop-up Entry

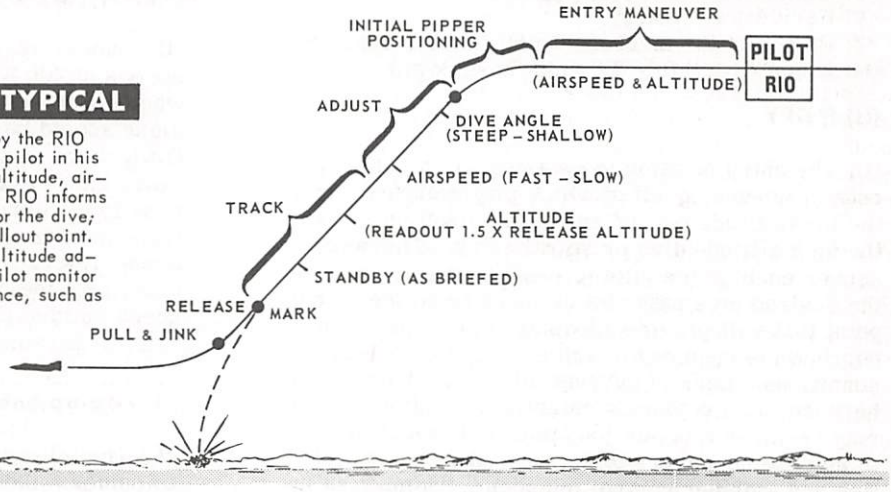
(U) The following is a thumb-rule that may be used to perform the pop-up entry maneuver. The pullup point, where the climb is initiated, can be determined by using figure 2-69. Enter the Dive Angle/Horizontal Distance chart (figure 2-69) with the desired entry height (12,000 feet) and dive angle (40°). The horizontal distance from target is then 14,200 feet. The pop-up distance from target is then 2.5 times 14,200 feet, or 35,500 feet. During the approach to the pullup point, establish the planned release true airspeed and MIL PWR. At the pullup point, initiate a climb angle on the ADI that is equal to the planned dive angle. Position the climb path left or right of the target to enhance target acquisition during the climb. At 1000 feet below the planned entry altitude, roll the aircraft inverted and continue to maneuver to the desired entry position. If the entry height exceeds 7000 feet, combat rated thrust (CRT) may be required after initiating the pop-up maneuver.



PILOT/RIO COMMENTARY

TYPICAL

The RIO conventional weapon commentary is used by the RIO during a conventional weapon delivery to assist the pilot in his run. By use of this commentary, the RIO monitors altitude, airspeed, and attitude. At the prebriefed altitudes the RIO informs the pilot, by intercom, as to; dive angle; airspeed for the dive; approaching release point, standby, release, and pullout point. For dive angles other than illustrated, appropriate altitude adjustments must be made. It is imperative that the pilot monitor altitude and remain prepared for an unusual occurrence, such as intercom failure.



EXAMPLE

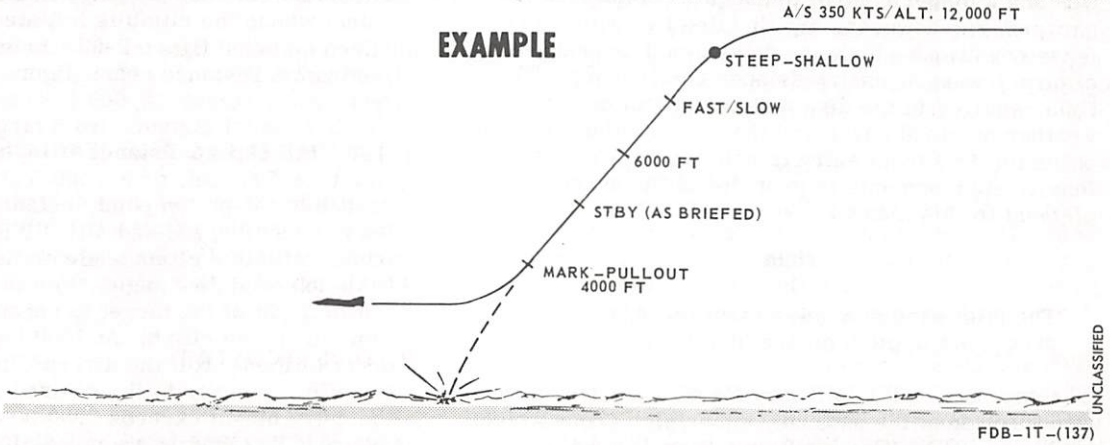


Figure 2-41 (U)

(U) TRACKING

(U) Tracking consists of acquiring the target (or aim point) in the gunsight and establishing a rate of pipper movement that will place the pipper on the target at the instant the aircraft arrives at the release altitude on the dive angle and with the airspeed for which the sight setting was computed. Airspeed and dive angle control are achieved with relatively less problems than solving the problem of tracking to release point. Tracking can be accomplished by placing the pipper on the target immediately after dive entry (curvi-linear), placing the pipper at the 6 o'clock position and allowing it to move to the target (straight path), or placing the pipper at 6 o'clock and pulling through the target with a constant 1 G acceleration (1 G loading). Refer to figure 2-42.

(U) Curvilinear Tracking (Bunting)

(U) There is a hazard of bomb-to-aircraft collision, and corrections during the run are difficult to apply. When the gunsight pipper is held on the target during the dive, the aircraft flight path becomes convex and the dive angle is simplified since the pipper is held on the target until weapon release.

(U) Straight-path Tracking

(U) The aircraft follows a straight line path during the dive while the pipper moves forward as the altitude is decreased. The G load becomes slightly less than 1 G, but still affords good bomb-to-aircraft separation. The G load is 1 G in level flight and approaches 1/2 G in a 60° dive. The actual G load equals the cosine of the dive angle (less than 1 G). Rules of thumb for pipper position control are provided under Recommended Tracking Method.

(U) During straight-path tracking, the dive angle remains constant as the pipper moves toward the target or offset aimpoint. As the dive progresses, two factors combine to produce pipper movement. The first factor is aircraft travel across the ground which moves the pipper toward the target. The second factor is fuselage angle of attack which decreases as the aircraft accelerates in speed during the dive and tends to moves the pipper toward the nose of the aircraft. Therefore, when tracking while stabilized at the release speed, apparent pipper motion over the ground is rapid. When tracking while speed is accelerating, apparent pipper motion is slower due to the decreasing angle of attack.

Note

All Sight Angle charts and tables and the External Stores Limitations are based on the assumption that a straight-line flight path is maintained during the final portion of the dive until after last bomb release.

(U) One-G Load Tracking

(U) The pipper is initially placed on a 6 o'clock position and as the release point is approached 1 G acceleration is applied causing the pipper to sweep through the aimpoint. A 1 G load is greater than the G load required for a straight-path dive, therefore the flight path is curved (concave) and the dive angle is continuously decreased during the dive. One G (or more) at bomb release provides the best bomb-to-aircraft separation. However, the constantly changing dive angle and the rapid pipper movement at release make it an impractical method for accurate bombing.

(U) Recommended Tracking Method

(U) The combination of curvilinear and straight-path dive tracking is recommended as the method that provides position checks and reduces the variables in the dive bombing run. The pipper is initially held a fixed number of mils below the target. Then, at a predetermined altitude, the pipper is allowed to move toward the target so that a straight-line flight path is achieved during the final tracking portion of the dive until release.

(U) Some rules of thumb for pipper position during a straight-path dive are as follows:

a. Pipper is two-thirds of the sight setting below the target at three times the release height (feet, AGL).
b. Pipper is one-half of the sight setting below the target when the aircraft is at twice the release height.
c. Pipper is one-third of the sight setting below the target when the aircraft is at 1.5 times the release height.

(U) The thumb rules are derived from the ratio of the pipper position (relative to the target) to the sight setting being equal to the ratio of the slant range to the release point as compared to the slant range to the target. By substituting altitude for slant range, the rules of thumb are apparent.

(U) When using the curvilinear/straight-path combination method, the pilot should choose one of the check points described above for pipper position in a straight-path dive. Either the 1.5 times the release height or the 2.0 times the release height check point is recommended. The pilot then positions the pipper at the chosen distance below the aim point (or below the target during no-wind) until the corresponding altitude is reached. A minimum tracking time of 4 seconds should be provided. Weapon release should be accomplished with the aircraft in a straight line flight path (constant dive angle) and coordinated flight.

(U) ALTIMETER LAG AND REACTION TIME

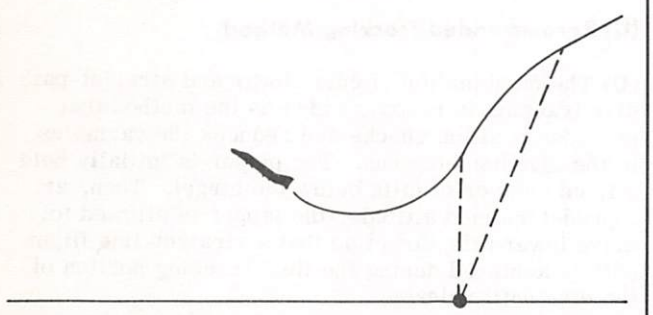
(U) Altimeter lag and the pilot's reaction time combine to cause the release height to be lower than desired. Refer to the description of the Altimeter Lag chart, part 4 of this section.

(U) DIVE RECOVERY

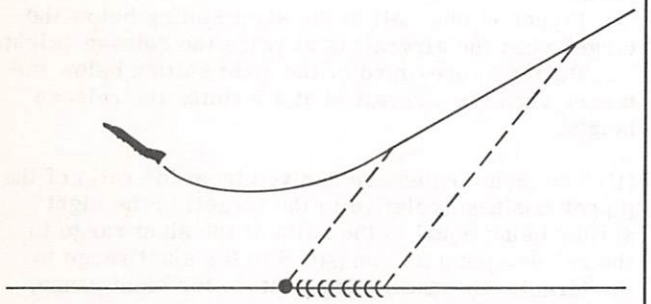
(U) Three recovery maneuvers available to the pilot are: (1) the wings-level, 4.0 G or 5.0 G pull-out to a climbing attitude; (2) the straightaway, full power, flat-out recovery; and (3) the 4.0 G breakaway turn.

TRACKING

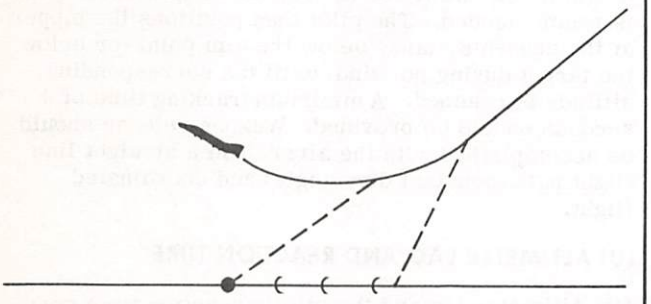
1 CURVILINEAR TRACKING (BUNTING)



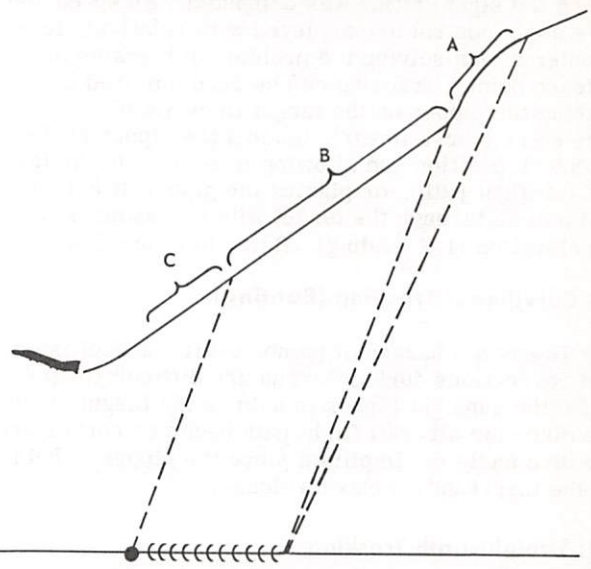
2 STRAIGHT-PATH TRACKING



3 ONE-G LOAD TRACKING



4 RECOMMENDED TRACKING METHOD



A. CURVILINEAR (BUNTING)
B. STRAIGHT-PATH
C. FOLLOW-THROUGH AFTER RELEASE
● PIPPER ON TARGET AT RELEASE
(PIPPER MOVEMENT WHILE TRACKING.

UNCLASSIFIED

FDB-1T-(215)

Figure 2-42 (U)

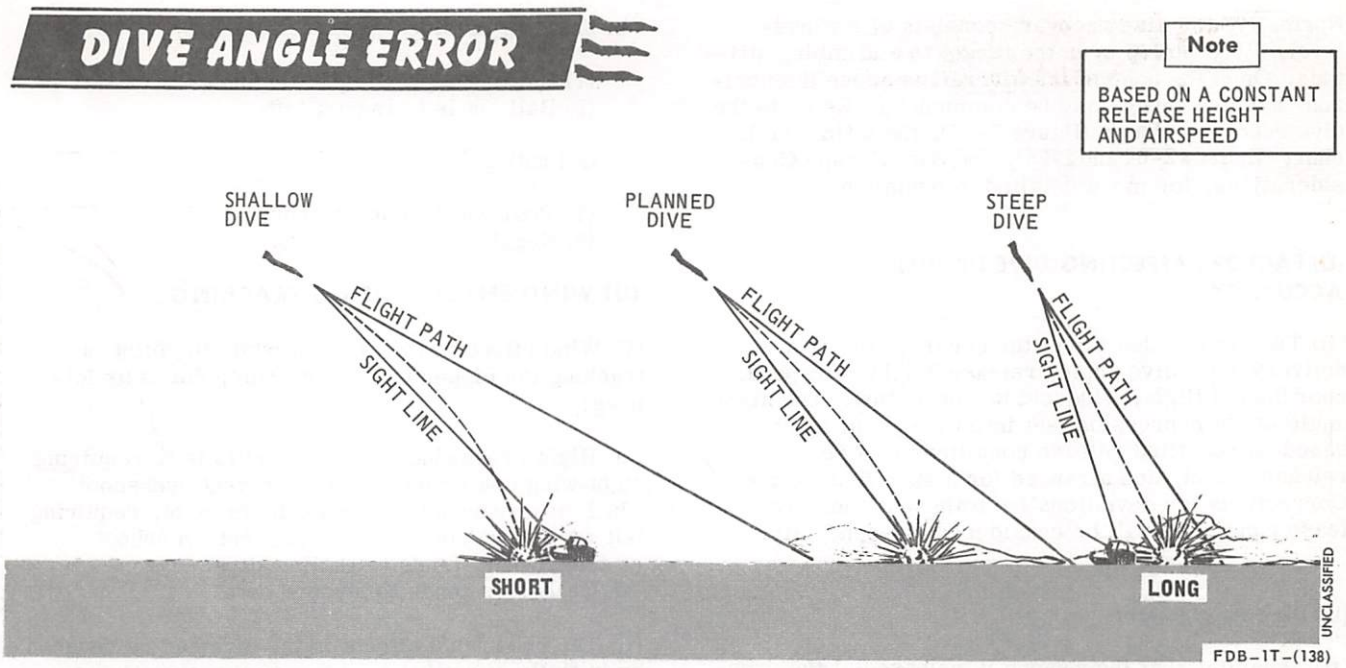


Figure 2-43 (U)

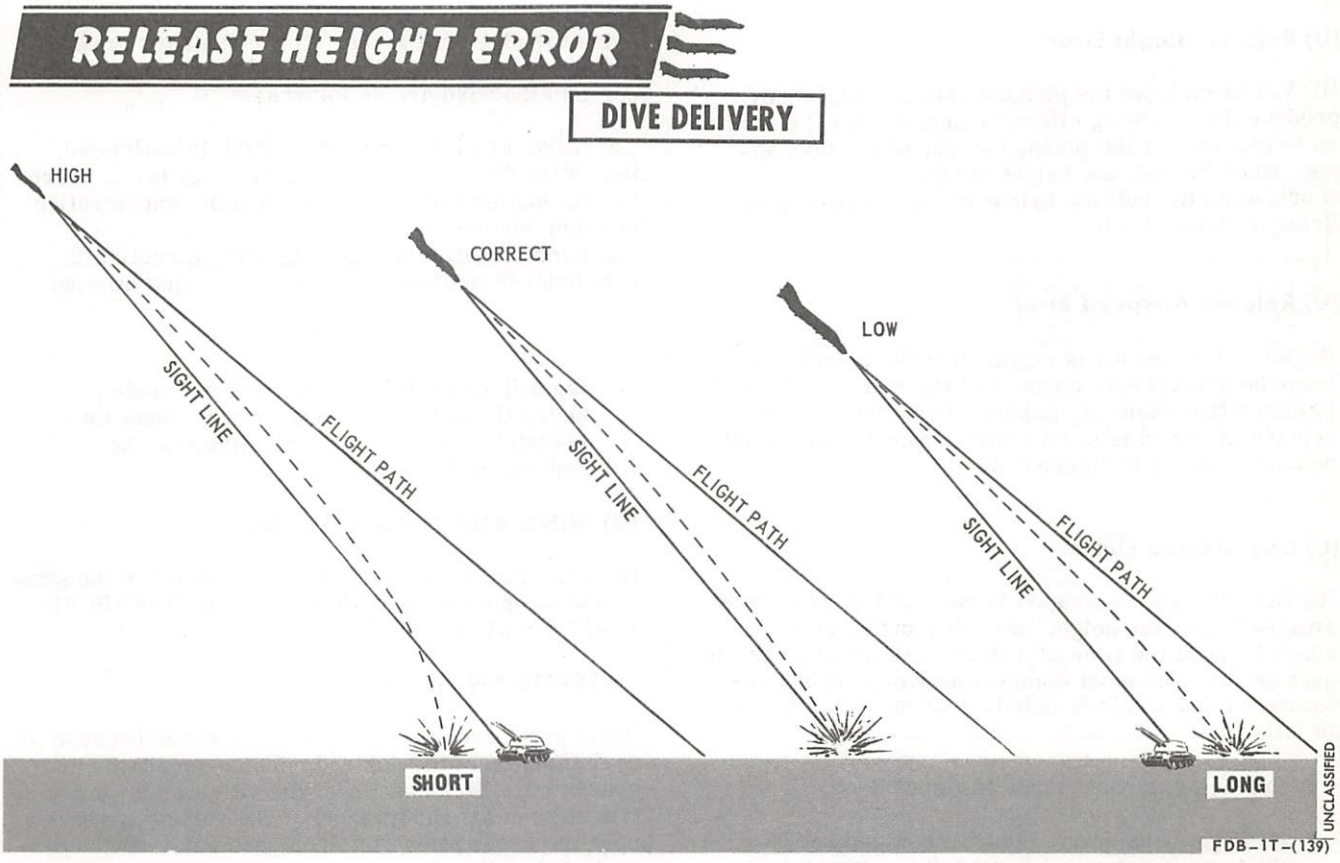


Figure 2-44 (U)

Normally, the dive recovery consists of a wings-level, 4.0 G pullup over the target to a climbing attitude. Once the nose of the aircraft is above the horizon, evasive action may be commenced. Refer to the dive recovery charts (figure 2-67), the altimeter lag chart (figures 2-64 and 2-65), and Safe Escape Considerations, for more detailed information.

(U) FACTORS AFFECTING DIVE DELIVERY ACCURACY

(U) The factors that affect the accuracy of the dive delivery are: dive angle, release height, airspeed, coordinated flight, wind and target motion. The sight angle (sight depression) set into the optical sight is based on specified release conditions of dive angle, release height, and airspeed for a specified weapon. Corrections for deviations from these planned release conditions will be considered independently.

(U) Dive Angle Error

(U) Assuming that the weapon is released at the proper airspeed and release height, variations in dive angle would have the following effects: when the dive angle is steep, impact is long; when the dive angle is shallow, impact is short. Refer to figure 2-43.

(U) Release Height Error

(U) Variation from the planned release height will produce the following effect, assuming that the weapon is released at the planned airspeed and dive angle: when the release height is high, impact is short; when the release height is low, impact is long. Refer to figure 2-44.

(U) Release Airspeed Error

(U) When the weapon is released at the planned release height and dive angle, and the release airspeed is faster than planned, impact will be long. If the release airspeed is slower than planned, impact will be short. Refer to figure 2-45.

(U) Coordinated Flight

(U) Even though the weapon is released at the planned airspeed, release height, and dive angle, uncoordinated flight at the time of release will produce an impact error. The most common delivery errors encountered and a rule of thumb, that may be used, are as follows:

a. Release in a bank (refer to figure 2-46).

(1) Right wing down, impact right and short.
(2) Left wing down, impact left and short.

b. Skidding or sideslipping.

(1) Ball out right, impact right
(2) Ball out left, impact left.

c. G-loading.

(1) Positive G, impact short.
(2) Negative G, impact long.

(U) WIND EFFECTS DURING TRACKING

(U) Wind effect on the aircraft while the pilot is tracking the pipper toward the aim point is as follows:

a. Right crosswind: aircraft drifts left, requiring right wing down correction to prevent overshoot.
b. Left crosswind: aircraft drifts right, requiring left wing down correction to prevent overshoot.
c. Headwind: tends to shallow dive.
d. Tailwind: tends to steepen dive.

(U) The crosswind effects in the dive can be reduced by initially offsetting the pipper into the wind to minimize the correction required during tracking (figure 2-47). The proper distance to offset is entirely pilot judgement based on experience. Therefore, while in training on raked practice targets, pilots must be aware of wind velocity (direction and speed) to gain an appreciation for wind effect and learn to judge drift rates. The advantages in estimating crosswind drift effect and offsetting the pipper into the wind are as follows:

a. If the offset distance is accurately estimated, the entire dive can be performed wings level, thereby eliminating one variable to permit concentration on other factors.
b. Even too little offset in the right direction is beneficial in minimizing the error caused by wind.

Note

Regardless of the drift corrections made during the dive, the wings must be level immediately before release to eliminate the bank error factor.

(U) WIND AND TARGET MOTION

(U) The effect of wind and target motion are the same except in opposite direction. Refer to NAVAIR 01-1C-1T for wind correction.

(U) ERROR ANALYSIS

(U) Impact errors which may be expected because of deviations from the desired release conditions are presented as Release Error Sensitivities in part 4 of this section for each weapon. The values are based upon the assumption that each parameter is independent of the others.

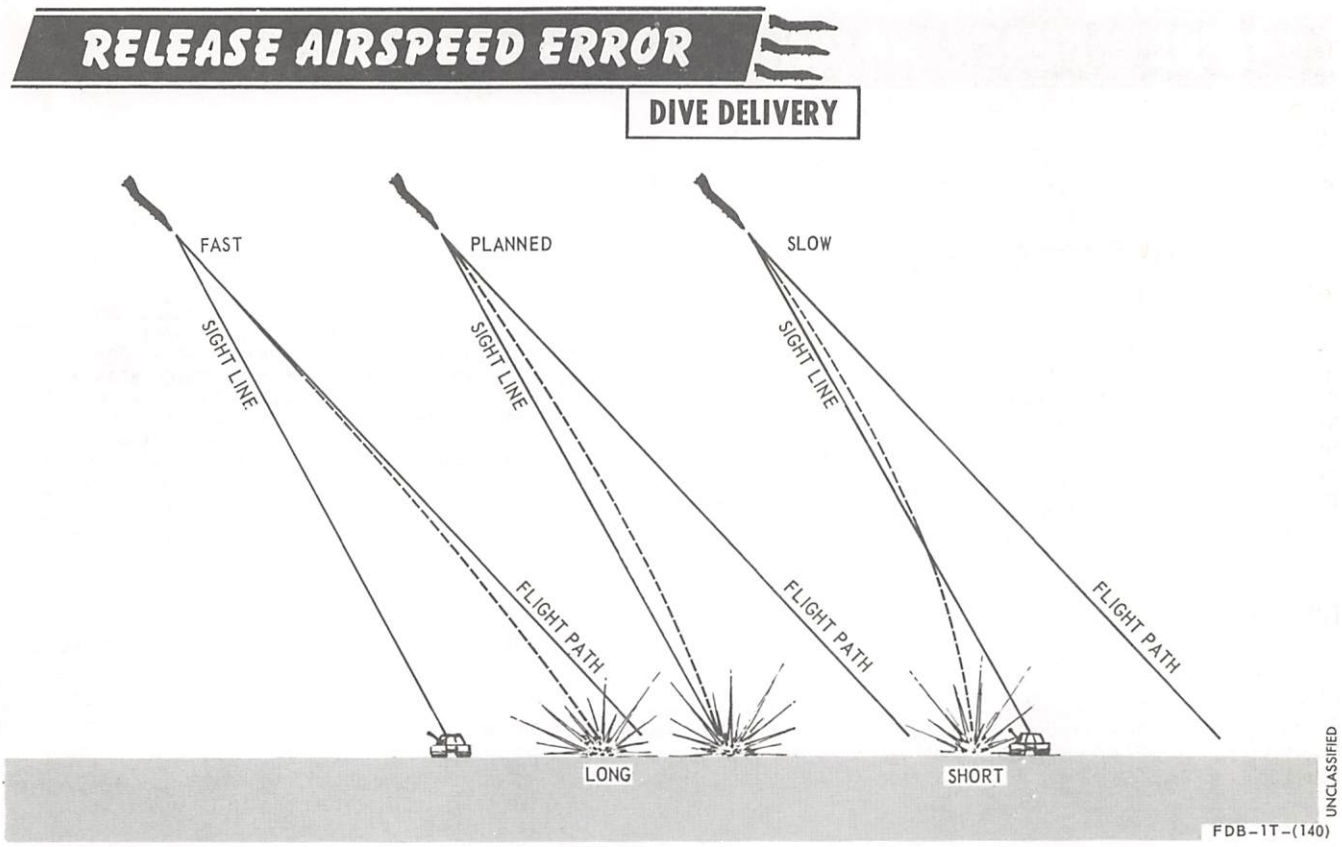


Figure 2-45 (U)

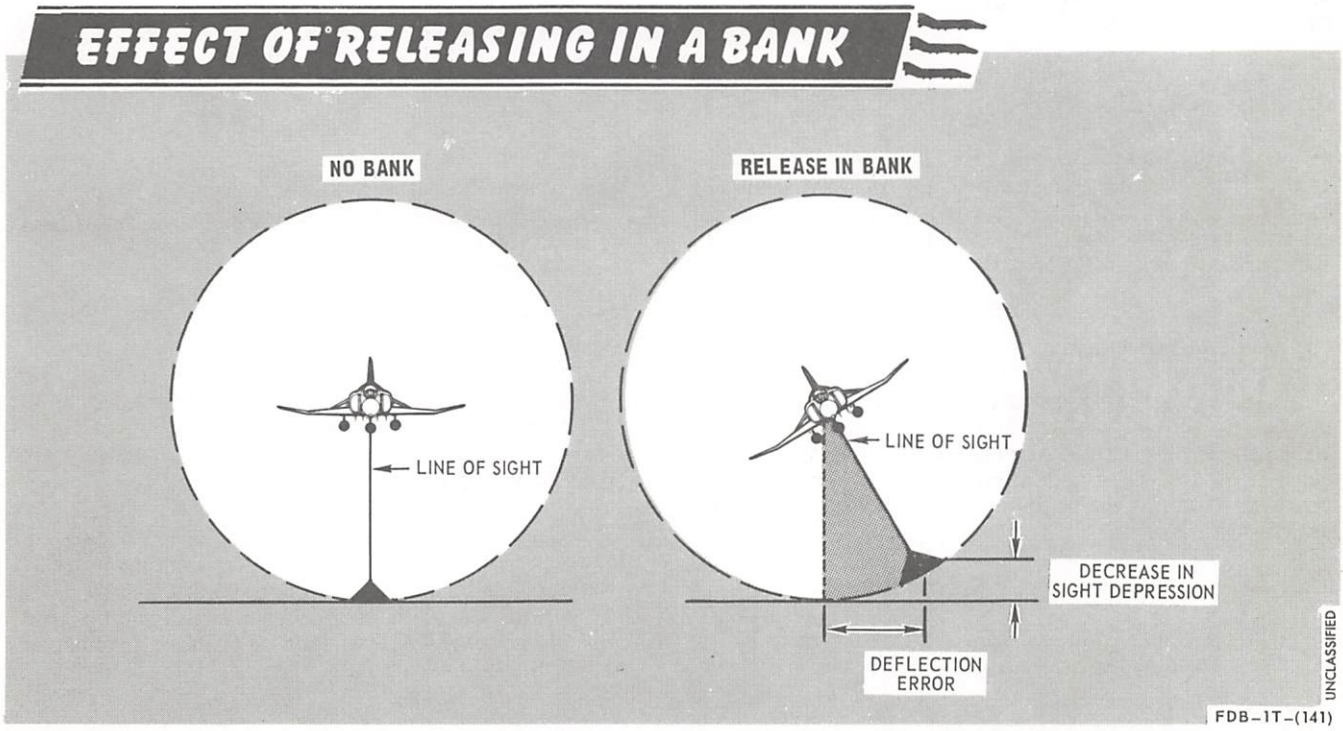
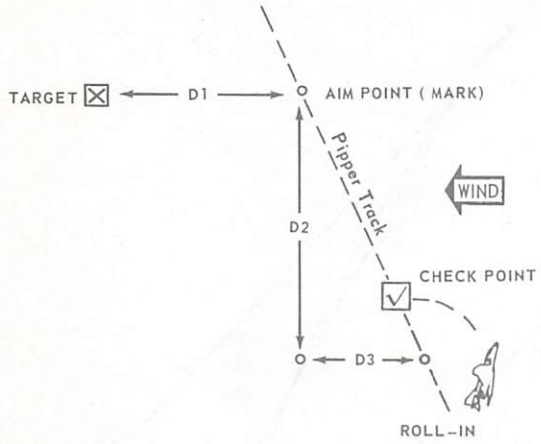


Figure 2-46 (U)

PIPPER TRACKING AND WIND EFFECT



FOR THIS ILLUSTRATION THE WIND IS CONSIDERED TO BE CONSTANT AT ALL ALTITUDES. PIPPER TRACK DURING ROLL-IN VARIES WITH THE METHOD USED. PRIOR TO THE CHECK POINT, CURVILINEAR TRACKING METHOD IS USED (AIRCRAFT IS DRIFTING LEFT). FROM CHECK POINT THROUGH THE AIM POINT, STRAIGHT PATH TRACKING IS USED (AIRCRAFT IS DRIFTING LEFT).

D1 = Computed up-wind aim point (Refer to Up-Wind Aimpoint)
D2 = Thumb rule checkpoint (Refer to Recommended Tracking Method, Dive Delivery)
D3 = Estimated drift and offset correction.

UNCLASSIFIED

FDB-1T-(142)

Figure 2-47 (U)

LEVEL DELIVERY CONSIDERATIONS

(U) GENERAL

(U) Level bombing techniques are used primarily for the delivery of fire bombs, cluster bombs, and retarded bombs. Unretarded general purpose bombs are not suited for level delivery because of high depression sight angles required at the higher altitudes to avoid the danger of penetrating fragmentation patterns. Low level attack minimizes detection by the enemy, however, exposure to small arms fire is increased. High delivery airspeeds reduce vulnerability to small arms fire, and target acquisition ability. Target identification and briefing will provide the final inputs to the delivery problem. The importance of preplanning cannot be over emphasized.

(U) Since the velocity of the aircraft is imparted to the weapon at time of release, it is of utmost importance that steady state flight be achieved. All level releases must be accomplished in 1G level flight. Steady state tracking is an absolute requirement; however, tracking time must be less than the time required by the enemy to bring effective fire to bare. Pattern elevation will vary with target visibility and adjacent terrain clearance. Roll-in tactics usually require that visual contact with the target not be broken. Usually, 1000 to 2000 feet AGL is an adequate pattern height. At the roll-in point, a descending turn to a level attack path is established. Compensate for crosswind by offsetting the pipper position left or right of the target. (Refer to Wind Correction.)

(U) Since the altimeter is the RIO's primary release cue, the pilot will have to determine the release point in level delivery. The RIO's response is limited to airspeed. Pitch trim is important to achieve steady state level flight. When the bomb release button is depressed, it is imperative that the pilot pause prior to initiating a pull-off to preclude tossing the weapons. A smooth 2 to 4 G pull-off with appropriate evasive tactics and positioning for re-attack are executed after weapon release.

(U) When determined that a level delivery will be employed, the mach bug should be set at the desired release Mach number, the sight should be depressed to the proper sight angle, and the pressure altimeter and the radar altimeter should be set. The primary considerations during the attack are: correct airspeed, release height, level flight, and wind correction. After completion of the weapon release continue straight ahead or perform appropriate evasive maneuver. Refer to figure 2-48.

(U) FACTORS AFFECTING LEVEL DELIVERY ACCURACY

(U) The level delivery maneuver is a special case of the dive delivery maneuver where the dive angle is zero. The basic factors that affect the accuracy of the dive delivery also affect the level delivery accuracy. Refer to figures 2-49 and 2-50 for errors produced by deviations in release airspeed and release height.

(U) Wind and Target Motion

(U) The wind has an affect upon the aircraft prior to release and upon the weapon after release. An approximation of the correction required (in feet or Mils) for the relative wind at the release altitude can be determined as follows: Wind correction in feet = weapon time of flight, times 1.7, times the wind speed in knots. Refer to figure 2-58. Target travel is determined by estimating the speed and course of the target and predicting the position of the target at the time of weapon impact. The predicted target position then becomes the aim point.

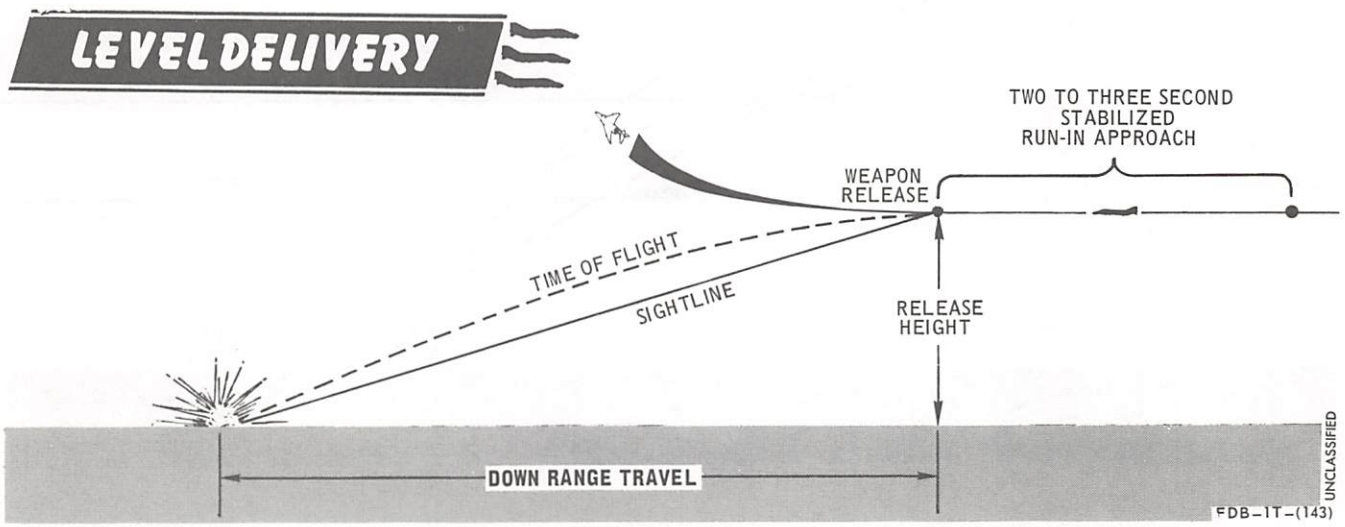


Figure 2-48 (U)

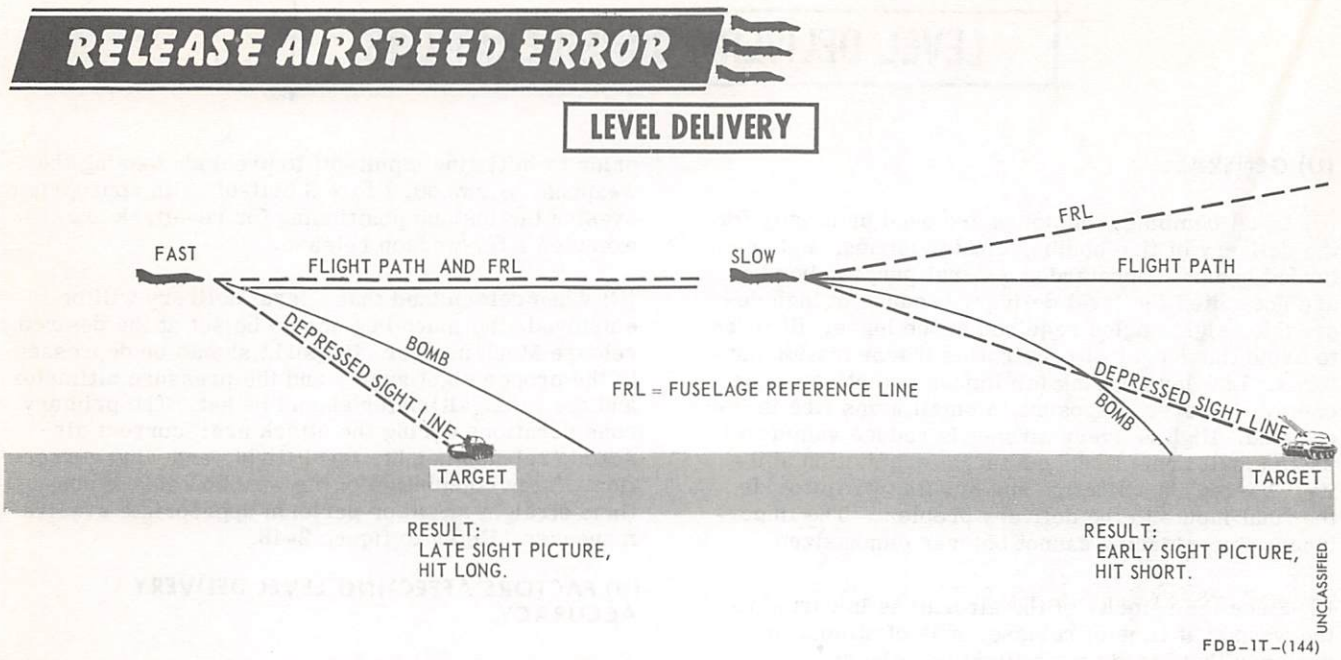


Figure 2-49 (U)

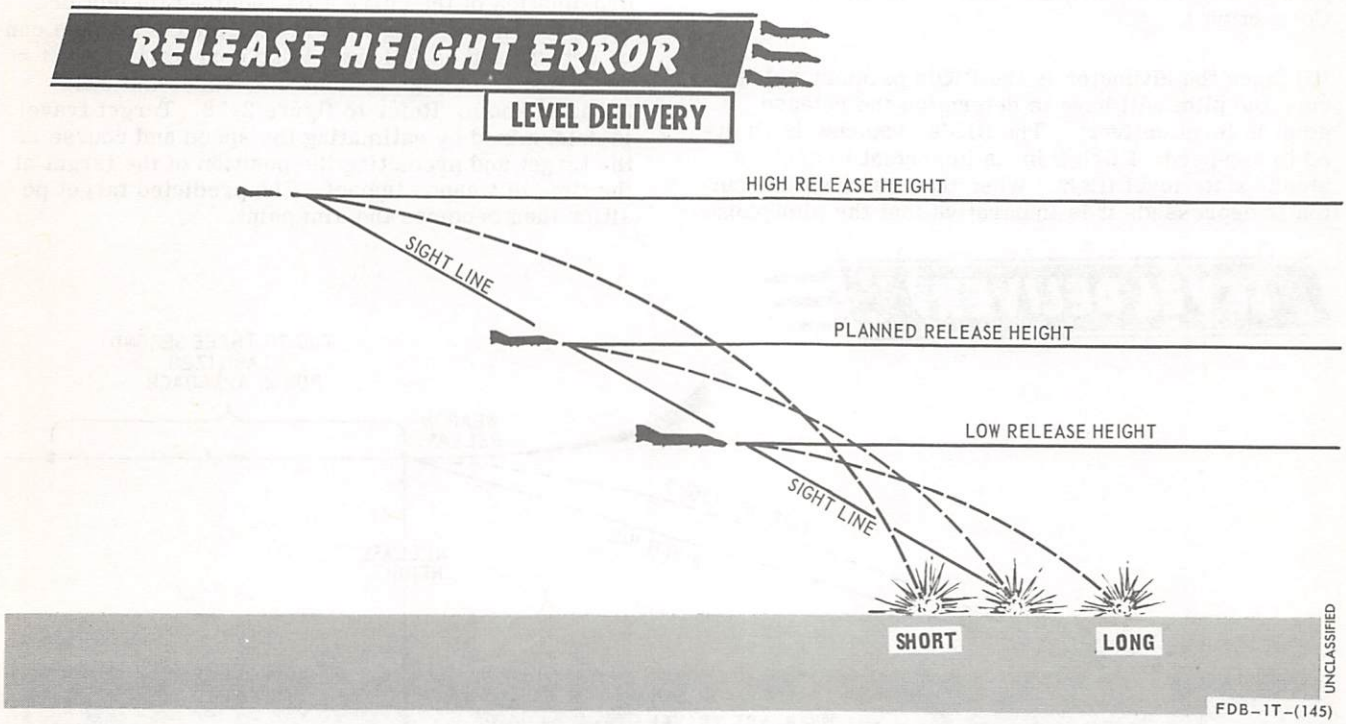


Figure 2-50 (U)

MULTIPLE RELEASE CONSIDERATIONS

(U) A multiple release may be accomplished during a single delivery maneuver. The aircraft intervalometer is normally used to program the multiple release; however, when a programmed interval is not available, the pilot may perform a multiple release manually. To accurately perform a multiple weapons release maneuver, the single release maneuver is used with the following modifications. (Refer to figure 2-51.

a. For the dive delivery, adjust the initial release height upward to permit the last bomb to be released from a height that will provide safe escape.

b. Adjust the sight angle to place the center of the pattern on target.

c. Maintain a straight line flight path during the multiple release.

d. Hold pickle for duration of ripple/cluster release.

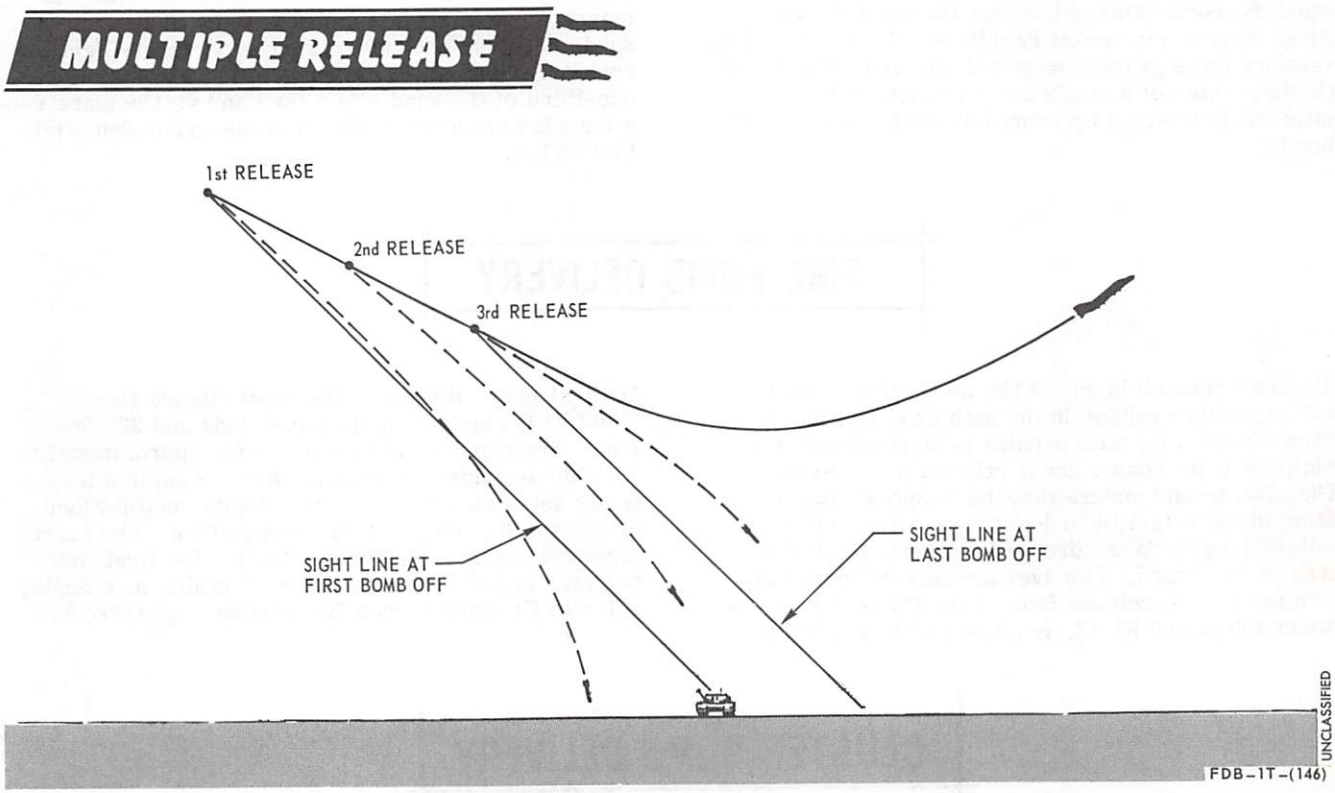


Figure 2-51 (U)

ROCKETRY

(U) Rockets are normally used when aircraft guns would have little affect on targets such as tanks, bunkers, buildings, railroads, and vessels. Since rockets are explosive missiles, blast or fragmentation damage to the delivery aircraft during recovery necessitates that rockets be fired at a greater slant range than guns. Rocket firing techniques are generally no different than those outlined for dive bombing.

(U) At time of launch, the velocity of the rocket is only slightly greater than the velocity of the aircraft when the rocket fins orient into the relative wind. After launch, the rocket rapidly accelerates to a high velocity while gravity pulls it downward. The ballistic dispersion of a single rocket is approximately 5 mils but is affected by many factors not common to bombs.

(U) Other items to consider which alter the dive recovery technique are: (1) possible foreign object damage to the aircraft from failures of the rocket and its components and (2) aircraft engine instability is possible due to rocket gas ingestion. To avoid possible foreign object damage (such as rocket fins, nose cone fragments and rocket ignitor clips), pull up and away from the attack run as soon as the last rocket is observed to fire.

(U) Rocket delivery patterns do not vary greatly from dive bombing; therefore the technique for roll-in and tracking are unchanged. Corrections for wind and moving targets are the same except that less offset is required because of shorter time-of-flight for rockets. Wind effect for rockets is approximately one-third of the wind effect for bombs. Compare relative wind corrections listed in the Error Sensitivities tables.

FIRE BOMB DELIVERY

(U) The firebomb is one of the most lethal, accurate, and versatile weapons in the high explosive inventory. Even a near miss with napalm is highly destrive of equipment; personnel are particularly vulnerable. The pilot should ensure that the weapons impact short of the target by at least one-half the effective pattern length. When dropped in pairs, the lethal area is increased. The average eliptical burn pattern for a level release from 35 to 100 feet AGL, between 400 to 500 KCAS, is 50 feet wide and 250 to 300 feet long. However, the most intense fire (1300°F) is approximately 4 feet wide and 200 feet long. The napalm mixture burns for approximately 15 to 30 seconds. Increasing the dive angle effectively decreases the forward velocity vector which decreases the length of the burn pattern. The maximum dive angle considered effective for firebomb delivery is 30°. For maximum allowable dive angle, refer to External Stores Limitations, appendix A. NEW

CLUSTER BOMB DELIVERY

(U) CBU-24, -29, -49 CLUSTER BOMB

(C) The CBU-24, -29, -49 cluster bomb unit is designed for use against personnel and light material targets. Refer to part 4 for weapon description. A CBU dispenser that fails to open (M907 fuze failure) will probably give a high order detonation on impact equivalent to a 500 lb bomb (based on USAF tests). The CBU should not be carried at low altitude over areas of intense AW ground fire due to the probability of a 30-caliber bullet setting it on fire or a 50-caliber bullet detonating it (based on Picatinny Arsenal and NWL Dahlgren tests). Briefed delivery conditions must be rigidly adhered to in order to prevent the weapons from functioning too low to be effective. The fuze tolerance of the M907 is too high and generally on the long side of the set time. Delivery conditions, particularly release altitudes, should reflect this knowledge. NEW NEW NEW NEW

(C) The impact for the BLU-26/B bomblets is somewhat unusual compared to other types of cluster munitions. The lift created by the spinning bomblets causes them to fly outward at approximately a 20° angle from what would be considered a normal trajectory. The effect of this is to create a doughnut shaped pattern. The shape of this pattern closely resembles an ellipse with the length (along the direction of drop) being somewhat greater than the width. The majority of bomblets (90%) fall within a band defined by the outer and inner perimeters of this ellipse. The size of the outer perimeter is a function of dispenser opening height above the ground, dispenser attitude or dive angle, and airspeed. A rough NEW NEW NEW NEW

(C) approximation of pattern size can be obtained by the following rule of thumb:

45° Dive: pattern length = 0.4 x dispenser opening height AGL in feet.

35° Dive: pattern length = 0.5 x dispenser opening height AGL in feet.

(C) Refer to the CBU-24, -29, -49 Pattern and Arming charts for planning pattern diameter as a function of release altitude and fuze function time. The following formula can also be used to figure function altitude:

$\Delta H = 16T^2 + V_E T$, where:

ΔH = Altitude loss

T = M907 fuze setting

V_E = Ejection Velocity

(C) Regardless of the size of the outer perimeter of the pattern, the width of the band of bomblet impacts is always 150 to 200 feet. A high dispenser opening altitude will therefore give a large pattern with correspondingly large void in the center. Bomblet fuze function rate is also affected by dispenser opening altitude. When the dispenser opens at altitudes less than 1000 feet AGL, a high bomblet dud rate can be expected (25 to 50 percent). From 1000 to 2000 feet AGL, dud rates are from 3 to 8 percent and above 2000 feet the dud rate decreases to approximately 2 percent.

(C) Analysis of BLU-26/B effectiveness for a single CBU-24 pattern indicates that a pattern of 750 to 900 feet long and 700 to 800 feet wide will yield the most desirable results considering all aspects (i.e., bomblet fuze function rate, delivery accuracy and interbomblet spacing of the weapon). The void in the center of a pattern such as this will be large enough (300 to 400 feet) to preclude the use of a single weapon against point targets. To insure target coverage, a multiple-weapon drop is necessary. Ideally, a three-weapon drop with the pattern centers spaced 200 feet apart would fill the void area of the first weapon impact. In reality, this is seldom accomplished due to a ± 1-second tolerance in the M907 fuze. The effect of this timer tolerance (generally 0.3 to 0.6 seconds long) will be to vary the impact pattern centers short or long from optimum. The addition of a fourth weapon will increase the probability of target coverage. Refer to part 4 for weapon description, fuze description, typical impact patterns and fuze delivery limitations. Refer to appendix A for external store limitations.

(U) ROCKEYE II CLUSTER BOMB

(C) The Rockeye II is a cluster weapon designed for use against tanks and armored vehicles. It is also effective against parked aircraft, light armored vehicles, trucks, radar vane, surface to air missile sites, POL tanks, surface vessels and personnel. Refer to part 4 for weapon description, fuze description, impact pattern size and fuze delivery limitations.

(C) A single Rockeye II is an effective weapon against a point target. However, effectiveness studies show that a multiple weapon drop of up to four weapons will yield the most desirable results when all aspects are considered (bomblet pattern density and delivery accuracy when using a single-run tactic). Four weapons dropped in pairs are recommended for small point targets to increase bomblet density within the impact pattern.

(C) The recommended four-weapon stick of ROCKEYE II weapons has the highest probability of correct interbomb spacing at release intervals higher than the maximum 140 milliseconds available with the F-4. However, the 140-millisecond interval is satisfactory for deliveries of up to and including 30°. The following interbomb spacing will be obtained at a 140-millisecond release interval:

Dive Angle	450 Knots	500 Knots
30°	52 feet	60 feet
20°	60 feet	68 feet
10°	68 feet	77 feet
Level	106 feet	117 feet

Note

The aim point should be the center of the target (no wind), and the bomb button should be depressed as the pipper crosses the target and held until all weapons are released. During weapon release, the pipper should be allowed to track through the target until all weapons are released. When tactically feasible, delivery maneuvers requiring sight settings in excess of 240 mils should be avoided due to tracking difficulty and larger pendulum effect.

(C) In the event of a non-functioning intervalometer, or for stick releases at dive angles greater than 30°, ROCKEYE II may still be effectively delivered using the following technique. Position armament switches as required for single release (Bombs, Single). Upon reaching the desired release altitude, release the desired number of weapons using the "pickle-pause-pickle" technique. The timing interval should be approximated by mentally saying "pickle-pause-pickle." When using this technique, care should be taken to avoid releasing weapons at less than the authorized interval for the particular rack selected.

(C) The impact pattern for Rockeye II is rectangular in shape and has no holes as does the CBU-24 series. It does not change noticeably with changes in release altitude and airspeed. For dive angles of 30° to 60°, the pattern remains relatively fixed at about 250 feet in length and 200 feet in width with random bomblet distribution within. The center of the pattern has a slightly higher bomblet density than the rest of the pattern. Level and 10° deliveries at low release altitudes tend to lengthen the pattern to 350 to 400 feet and narrow it to about 150 feet. A time of fall of at

(C) least 3 seconds after dispenser opening is necessary for the pattern to properly form. A time of fall of less than 3 seconds will cause a very tight grouping of bomblets and an increased bomblet dud rate. Long slant range deliveries from high altitude result in a pattern density adequate for flak suppression. Refer to part 4 for Rockeye Pattern charts, Bomb Spacing charts, Sight Angle charts and Release Error Senitivities and Wind Correction tables. The shaded area on the Slight Angle chart indicates an area of release that will preclude dispenser opening at a satisfactory altitude, or which does not provide minimum terrain clearance for dive recovery. A minimum time of flight of 3 seconds after dispenser opening is necessary for the pattern to properly form. The charts give data for single weapon release.

(U) Recommended roll-in altitudes above release height for the following dive angles are:

Dive Angle	Roll-In
60°	REL HT +6000 feet
45°	REL HT +5000 feet
30°	REL HT +4000 feet
20°	REL HT +3500 feet
10°	REL HT +2500 feet
Level	As Desired

DESTRUCTOR DELIVERY

(C) The MK 36 DST is an aircraft-laid influence mine designed primarily for shallow underwater planting as a bottom mine with a secondary application as a land mine.

(C) The MK 40 DST is an aircraft-laid influence mine designed primarily for use as an antivehicular land mine with a secondary application as a shallow water mine. The MK 40 DST was developed to provide for a destructor with a larger explosive section to complement, rather than replace, the MK 36 DST. Only the MK 83 Mod 4 weapon can be used for MK 40 destructor operations. The MK 83 Mod 4 is fitted with seals specifically designed to ensure watertight integrity of the weapon.

(U) Refer to part 4 for weapon description, fragment envelopes, fuze description, and fuze delivery limitations. Refer to appendix A for external store limitation.

(C) The MK 36/40 DST should be place along bridges, highways, railroads and other lines of communications for the subsequent destruction of vehicles, troops or repair crews having sufficient magnetic signature to actuate the system. Destruction or damage is inflicted from fragmentation, blast or over-pressure and is a function of terrain, weapon burial, weapon orientation and the ability of the target to withstand the effects of the explosion.

(C) The Mods 2 and 3 were designed to provide an unretarded delivery capability for improved accuracy from a higher altitude than the retarded version allows. It is vitally important that the type soil of the impact area be considered when deciding on retarded or unretarded delivery. If the soil is of soft or medium hardness/density it is probable that an unretarded destructor will penetrate to a depth that renders it useless.

STRAFING

(U) GENERAL

(U) The basic weapon of the tactical fighter is the gun. The primary advantages of strafing are versatility, accuracy and concentration of fire. These advantages plus the projectile's short time of flight make strafing highly effective against a wide variety of targets. Due to the projectiles short time of flight, strafing is the most accurate method of performing an attack against any suitable target. Knowledge of the proper techniques, plus the ability to recognize, analyze, and correct for common pilot induced errors will enable a pilot to effectively destroy a pinpoint target, or to saturate an area target with 20mm projectiles.

(U) The same basic delivery techniques and procedures for bombing and rocketry apply to strafing. A few exceptions are: reduced pendulum effect due to small sight depressions, reduced wind correction factors due to short time of flight of the projectile, minimum firing altitude based upon firing time and altitude lost during recovery (rather than fuze arming and safe escape criteria) and ease of obtaining improved accuracy through reduced projectile dispersion and short slant ranges.

(U) LOW ANGLE STRAFING TECHNIQUES

(U) The strafing attack is easily performed and may be initiated from almost any condition of flight, with a minimum of pre-planning; however, for consistency and effectiveness, the pilot should strive for optimum firing conditions, dive angle, slant range, and airspeed. The attack can be initiated from a base leg, normally located at an altitude of 2500-3000 feet AGL, and a distance of approximately 10,000 feet from the target. In a combat situation where defensive weapons are present, a pitch-up to the roll-in position can be made, or a straight-ahead push-over or roll-ahead can be used.

(U) The roll-in from base leg (or from a pitch-up) to final attack heading tends to determine the quality of the attack. During roll-in, the aircraft should be maintained level for the first one-third of the turn to prevent shallowing of the dive angle. The roll-in technique must be varied to meet planned conditions. If the roll-in position appears to be too far out, the turn should be flown level, towards the target, until the desired dive angle can be intercepted. If too close in, the nose must be lowered immediately and pulled through to the desired dive angle. The roll-in (or turn) should be an aggresive, hard turn, easing to a 2G turn just prior to roll-out (because of the difficulty of making a precise roll-out from a hard turn).

(U) The airspeed at roll-in should be 50 to 75 knots below desired firing speed. Use power as necessary to accelerate fairly rapidly toward firing airspeed. The pipper should be placed 200 to 250 feet short of, and in line with the desired aiming point. As the airspeed nears the desired speed, a power correction is made and the pilot's attention is devoted to tracking, range estimation, and firing. As the slant range decreases, the pipper has an apparent tendency to walk toward the aiming point. While the pipper is moving up to the aiming point, smooth small corrections are made for line up error. The pipper should reach the aiming point just prior to the aircraft reaching desired firing range. Hold the pipper steady during firing. See figure 2-52.

(U) In low angle bombing, when release altitude is below approximately 2000 feet, the altimeter is not used to determine release altitude; the same is true in low angle strafing. Firing is commenced when the pilot achieves the correct sight picture for the desired slant range. When conducting low angle strafing, the pipper-to-target size relationship may be used as an aid in determining range. For example: when the 2-mil pipper matches the height of a door or a 6-foot vehicle, the slant range along the depressed sight line is approximately 3000 feet. Slant range along the flight path can be obtained from Dive Angle/Horizontal Distance chart.

Note

Slant range measured along the depressed sight line is contained in the ballistic tables of the air-to-ground Tactical Manual Ballistic Tables NAVAIR 01-1C-1T. Slant range from aircraft to impact can also be obtained from the TACTICAL MANUAL POCKET GUIDE error sensitivity tables by multiplying 1 mil left or right by 1000.

(U) Correction for firing in a wind or against a moving target, presents a problem similiar to that encountered in the delivery of bombs and rockets. The Bank Method and the Drift Method is discussed under the title Strafe Correction For Wind and Moving Targets, this section.

(U) The use of trim is extremely important in strafing as in any delivery. A slight amount of forward trim is desirable while firing on a point since it will help concentrate bullet impact and tends to prevent walking the burst. The most important factor in accurate strafing is to have the pipper on the desired aiming point when firing is commenced and to keep it there until the trigger is released.

(U) Low Angle Strafe Recovery

(U) The recovery should be initiated as soon as the trigger is released. Any delay in initiating recovery will increase chances of ricochet damage and could be fatal if the target explodes. When long bursts (1.5 seconds or greater) are fired, projectile impact can normally be observed just prior to initiating the recovery pull up.

(C) Immediately after cease fire, initiate a wings-level pullout, obtaining 4 to 6 G in 2 seconds. Assure the nose is well above the horizon before starting a reposition turn. Do not fly over the target if possible. This type recovery should normally be used because it reduces the possibility of damage from ricochets or from an exploding target. The break-away recovery tends to complicate the prediction angle for the defensive ground fire. Due to the type of enemy defense systems and tactics employed a straight-ahead, or zoom to a minimum safe altitude may be desirable over the break-away recovery.

(C) The weapons selector knob should be utilized as the safety switch. Every time the guns switch is placed to READY the gun is recycled, expending rounds and pneumatic pressure unnecessarily. With the weapons selector knob in CONV OFF - NUCL ON, all electrical power is removed from the gun pod to safe the gun.

(U) HIGH ANGLE STRAFING TECHNIQUES

(C) Establish the desired altitude and airspeed, and maneuver the aircraft to the proper roll-in position as determined by a known cockpit reference. During the final turn, maintain visual reference with the target. Do not attempt to fly the sight around to the desired aiming point. Roll out from the final turn in a slightly steeper dive than desired and place the pipper just below the desired aiming point. Always check for balanced flight (with the aircraft in a wings-level attitude) prior to commencing a strafing attack. Allow the pipper to drift smoothly up to the aiming point. Control the drift rate to position the pipper on the aiming point just prior to attaining desired open fire conditions. The open fire altitude is determined by an altimeter reference. As the aircraft passes through the standby call from the RIO, stabilize the aircraft in wings-level coordinated flight and fire on the mark call.

Note

Slant range measured along the depressed sight line is contained in the ballistic tables of the air-to-ground Tactical Manual Ballistic Tables NAVAIR 01-1C-1T. Slant range from aircraft to impact can also be obtained from the TACTICAL MANUAL POCKET GUIDE error sensitivity tables by multiplying 1 mil left or right error by 1000.

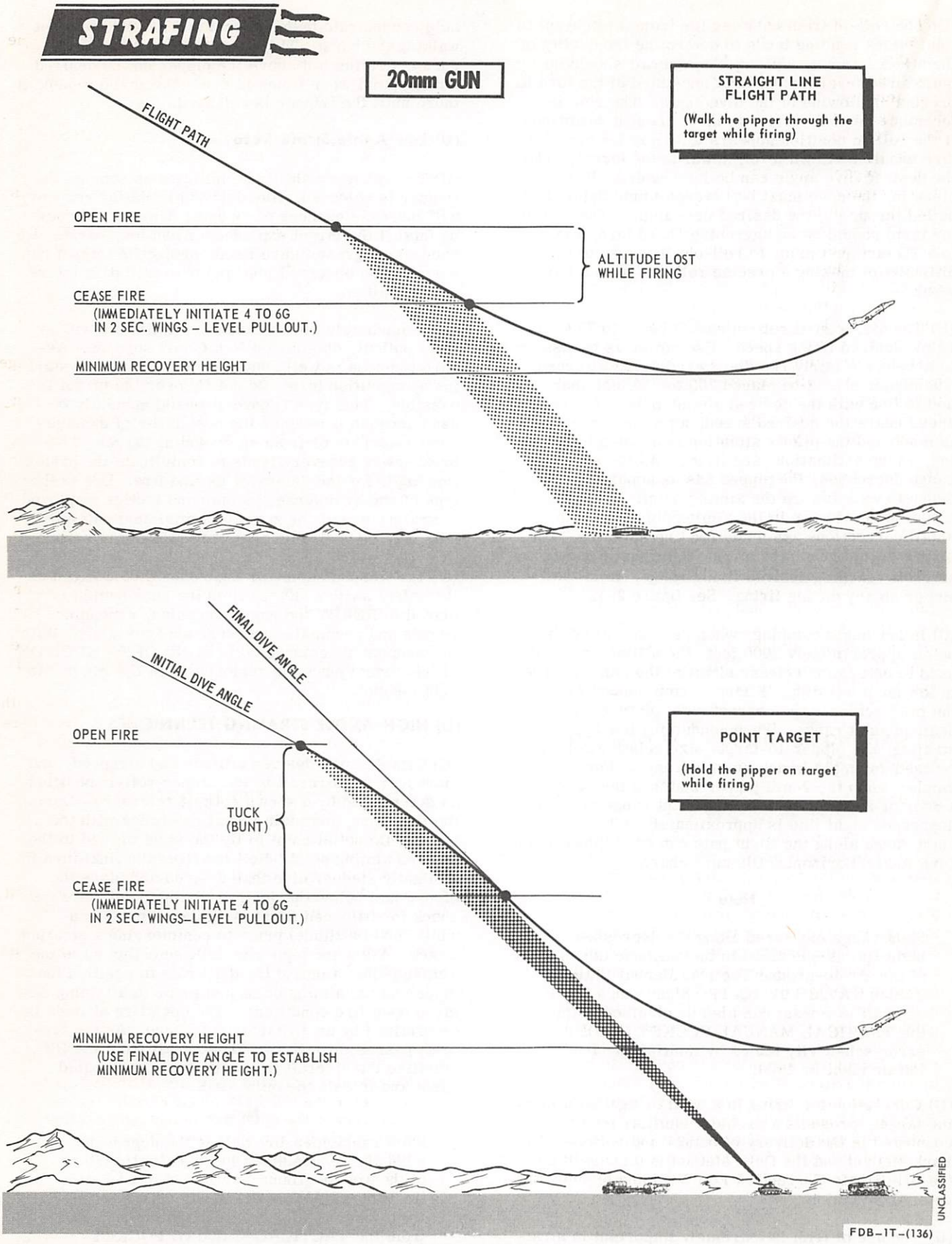

STRAFING
20mm GUN
STRAIGHT LINE FLIGHT PATH
(Walk the pipper through the target while firing)
FLIGHT PATH
OPEN FIRE
ALTITUDE LOST WHILE FIRING
CEASE FIRE
(IMMEDIATELY INITIATE 4 TO 6G IN 2 SEC. WINGS – LEVEL PULLOUT.)
MINIMUM RECOVERY HEIGHT
FINAL DIVE ANGLE
INITIAL DIVE ANGLE
OPEN FIRE
POINT TARGET
(Hold the pipper on target while firing)
TUCK (BUNT)
CEASE FIRE
(IMMEDIATELY INITIATE 4 TO 6G IN 2 SEC. WINGS–LEVEL PULLOUT.)
MINIMUM RECOVERY HEIGHT
(USE FINAL DIVE ANGLE TO ESTABLISH MINIMUM RECOVERY HEIGHT.)
UNCLASSIFIED
FDB–1T–(136)

Figure 2-52 (U)

(C) Combat strafing requires the trigger be held at least 1-1/2 seconds (100 rounds) to obtain the desired effective firepower. Altitude lost during firing must be computed and added to altitude lost during recovery to determine the open-fire altitude, use Strafing Down Range Travel and Altitude Loss charts. During the firing burst, down range travel causes a forward pipper movement with a corresponding projectile impact that walks off or beyond a point target. To concentrate all projectiles on a point target, hold the pipper on the aim point during the entire burst (see figure 2-52). This technique produces a tuck (bunt) and reduces firing accuracy, however, it is considered desirable for a point target. Projectile dispersion will compensate for the slight induced error. When the application of forward stick or reduction of back pressure is smoothly accomplished, the overall error will be very slight. Wind will present the pilot with some problems during the attack; however, they will be minor when compared to those incurred in dive bombing. As in low angle strafing the dirft method or bank method of wind correction/ target motion may by employed.

(U) High Angle Strafe Recovery

(C) The recovery should be initiated immediately after cease fire, by making a smooth, wings-level pull-up at planned G load, normally 4 to 6 G in 2 seconds. Assure the nose is well above the horizon before starting a reposition turn. If enemy AAA or automatic weapons constitutes a major threat, continue the climb in maximum power until reaching a minimum safe altitude. Evasive maneuvers (jinking) should be accomplished as necessary to negate enemy radar tracking or increase difficulty of manual tracking.

(U) STRAFING CORRECTION FOR WIND AND MOVING TARGETS

(U) Bank Method of Correction

(C) With the bank method of wind correction, the aircraft is banked into the cross-wind and the pipper is *walked* to the target as in a zero-wind track, to arrive at the desired aiming point just prior to the aircraft reaching the desired firing point. This method of correction is the most desirable, since firing in a bank produces no great problem in strafing. Although firing in a bank produces an impact error in the direction of bank and an undershoot error, the errors are so small they can be disregarded. Also, when firing in a bank, the pendulum effect on the pipper due to low mil setting, is negligible; therefore, the pilot can constantly maneuver to align the aircraft with the target without having to insure that the wings are level. Lateral trajectory shift is also negligible, enabling effective use of the rudder for pipper positioning just prior to firing and for maintaining the pipper on the aiming point during firing if necessary. The recommended technique is:

a. Determine the desired aiming point.
b. Roll in and place the pipper short of, and in line with the aiming point.
c. Compensate for wind drift by banking the aircraft into the wind.
d. Vary the angle of bank as necessary until just prior to reaching open-fire range, then strive to maintain a constant angle of bank with only smooth small corrections.
e. If necessary smoothly apply rudder pressure as necessary to maintain the desired pipper position throughout the firing portion of the pass. (This is only a correction for poor tracking techniques.)

(U) Drift Method of Correction

(C) With the drift method, the aircraft is basically positioned as in dive bombing. There is no advantage over the bank method other than firing in a wings-level position. The major disadvantage is that most pilots cannot accurately predict an up-wind roll-in point and therefore must bank the aircraft to reach the desired aiming point. If the drift method is performed in a strong crosswind, excessive rudder deflection will be required, resulting in an appreciable trajectory shift error; therefore, this method should not be used with strong crosswinds. The drift technique is:

a. At roll in, place the pipper below and a greater distance upwind than is necessary for the wind correction.
b. As the aircraft approaches the target, allow the pipper to move and drift downwind until the desired aiming point is reached.
c. Maintain the firing burst on the aiming point with smooth application of rudder during firing; over correct a little to compensate for trajectory shifts.

(U) MINIMUM OPEN FIRE HEIGHT

(C) The sight angle charts and the pocket guide establishes the minimum cease fire height (AGL) that ensures recovery above the minimum recovery height. The minimum open fire height is determined by adding the altitude loss during the burst to the minimum cease fire height. Use the Strafing Down Range Travel and Altitude Loss charts, part 4 of this section.

Note

To find the indicated open fire altitude, add altimeter lag (SPC ON or OFF) and target elevation to the open fire height. Select the sight angle for the open fire height corrected for gross weight deviation from 42, 000 pounds.

CONLABS DELIVERY

(U) GENERAL

(U) The CONLABS Delivery (figure 2-53) combines the use of the multiple weapons release system (MWRS) and the low altitude bombing system (LABS) to loft general purpose (GP) bombs. The maneuver increases weapon release range and does not require the delivery airplane to fly over the target. In CONLABS delivery planning, an initial point (IP) is selected that is near the target; the release angle is selected; the pullup point is computed, and; the LABS timer setting is determined. Refer to part 1, CONLABS Release System, for description of the controls and indicators and normal operating procedure. Detailed planning procedures are outlined in part 4, Weapon Delivery Data.

(U) CONLABS APPLICATION

(C) The ability to stand off two or more miles from a target and deliver conventional weapons with a reasonable degree of accuracy is highly desirable. This concept can be realized in a number of operational situations and is limited largely by the availability of a suitable IP, the accuracy of charts available for measuring IP-to-target range, and the pilot's ability to acquire the IP. Some possible applications of this tactic are:

a. Area targets - SAM sites, POL fields, supply depots, marshalling yards, dock areas, airfields.
b. Auxiliary targets - Rather than dumping ordnance into the sea -- satisfactory IP's could be established for ordnance disposal on more important targets. This concept has a significant potential for targets lying on or near the seacoast.
c. Inclement Weather - Targets which might normally have to be by-passed due to cloud coverage can be attacked when ceilings are no higher than the run-in altitude.
d. Radar IP's - Although this concept has not been tested, the possibility exists of furnishing the delivery aircraft with IP and heading information by means of onboard or remote (TPQ-10, etc) radar(s).
e. Coordinated Attack - This tactic has possible application as the initial or flak suppression phase of a large coordinated attack.

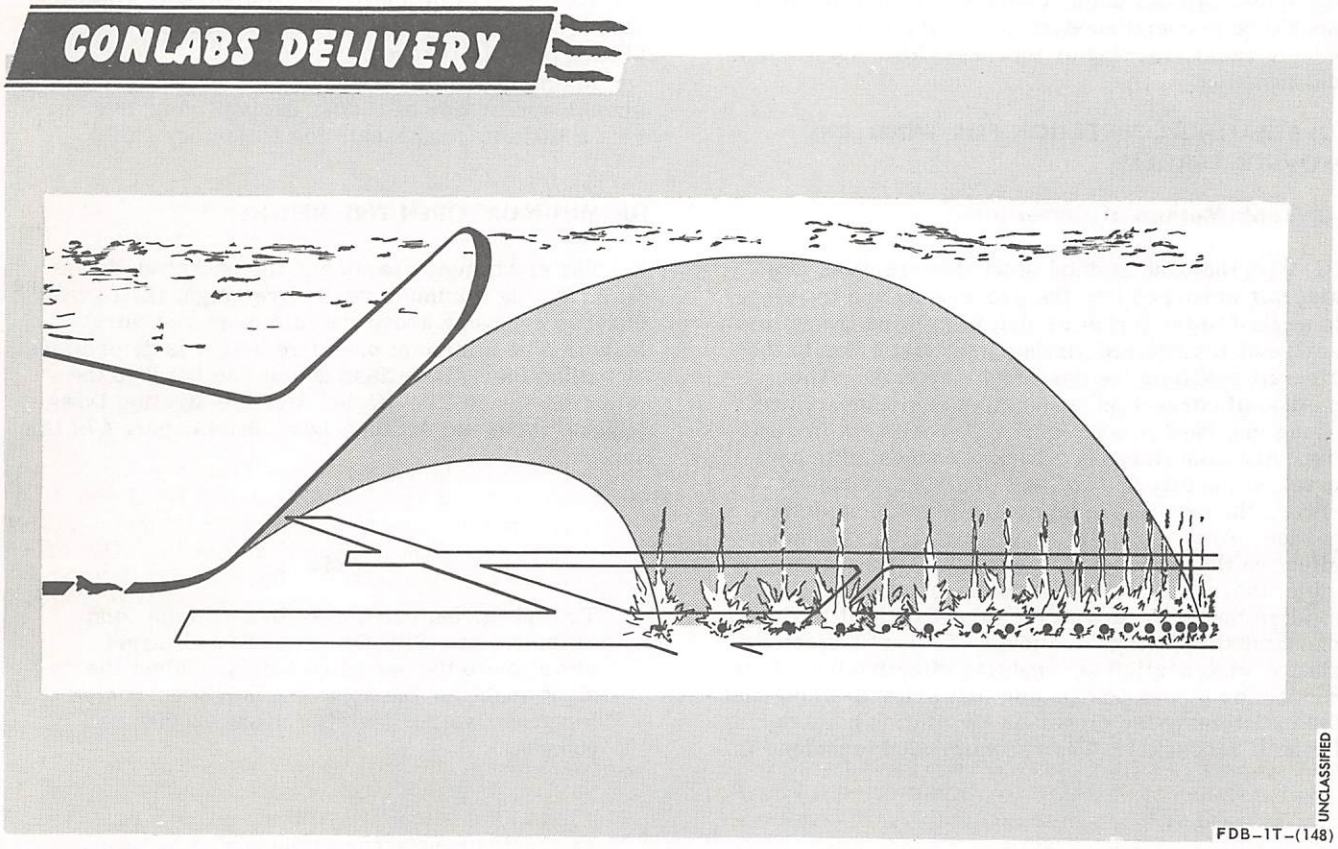


Figure 2-53 (U)

(U) Advantages

(C) CONLABS provide the following advantages over other conventional deliveries:

a. Multiple release of conventional bombs can be accomplished with a closest point of approach to the target of 2 miles.
b. The entire maneuver can be performed with an approximate 22-second transit of the lower fringe of the SA-2 envelope.
c. Coordinated attacks are easily timed and coordinated.
d. Greater interbomb spacing (sticklength) can be obtained from the same intervalometer settings than with other conventional deliveries.
e. This type of delivery can be performed in inclement weather conditions when low ceilings would preclude normal conventional deliveries.

(U) Limitations

(C) The following limitations must be carefully considered when planning a CONLABS attack:

a. An IP which can be visually acquired (or radar controlled) and which will allow accurate measurement of the range to target must be chosen, thoroughly planned, and traversed at the exact heading and airspeed to commence LABS timer rundown.
b. Range accuracy of this maneuver is a function of many variables. The range error probable (REP), assuming an accurate IP acquisition, should be approximately 200 feet to 500 feet for a single bomb.
c. Deflection errors are not as large as range errors in the CONLABS maneuver, provided visual target sighting is possible during the run-in. Deflection Error Probable (DEP), given visual target acquisition, should approximate 50 feet to 150 feet for a single bomb. If the pilot does not visually hold the target prior to the pullup maneuver, the deflection error will depend largely on the accuracy of the aircraft compass and the reliability of the heading information used in planning.
d. CONLABS deliveries must be thoroughly preplanned. The F-4B/N aircrew does not have the capability of setting the release angle in flight. The IP to pull-up distance must be accurately computed.
e. To be most effective, a RIPPLE release of 6 to 12 bombs per aircraft should be employed against a target.
f. Wind effects are much greater in CONLABS deliveries due to increased bomb time of flight.

(U) CONLABS PLANNING

(C) Thorough planning for a CONLABS mission is of the utmost importance. An effective strike cannot be accomplished without consideration of the following details:

a. Target - The target must be studied thoroughly with respect to size, composition, and shape to determine the most effective number of bombs, bomb spacing, and sticklength to be employed. Target elevation must be known to allow accurate computation of pull-up distances.
b. Initial Point (IP) - The accurate measurement of range from IP to the target is the most critical planning factor involved in CONLABS. The visual and radar acquisition potential of the initial point is also very important. The evaluation of the IP is a factor in determining the run-in altitude (MSL).
c. Configuration - Type and number of bombs must be known to determine optimum sticklength. Variations from computed gross weight will greatly affect the accuracy of the delivery.
d. Number of aircraft - Individual aircraft carriage, the size and type of target, and saturation desired are factors to be considered in determining the number of aircraft.
e. Intervalometer setting - Three intervalometer settings are presently available - 60, 100, and 140 milliseconds. This publication provides the data for planning RIPPLE mode releases for all three settings. Each delivery must be totally planned to determine the exact sticklength.
f. Recovery - If a reattack is not planned a wingover recovery to desired escape altitude should be performed. Do not use a roll-ahead recovery in any case.
g. Wingmen - Formation CONLABS attacks are feasible and often desirable. Positioning of the wingmen can be at the discretion of the leader, however it is desirable to place the wingmen in a loose echelon position and have them execute a conventional release upon visual and/or audio indication of the leader's release. This technique provides about 0.5 second delay between the leader's release and those of subsequent aircraft.
h. Fuzing - Either mechanical or electrical fuzes may be used. Close attention should be given the choice of fuze arming time to provide maximum safety and sufficient time of flight to arm.
i. Target weather and winds - Although Loft maneuvers can be accomplished in almost any cloud cover, the temperature and winds at the target should be considered in planning.
j. Alternative maneuvering - A course of action should be planned to provide for the possibility of the flight not visually acquiring the IP or not being established on airspeed and heading upon traversing the IP.

(U) DELIVERY TECHNIQUES

(U) Run-In Prior to IP

(U) Switches of the lead airplane should be set in accordance with the Tactical Manual Pocket Guide. F-4B/N aircrews will have had to set the RA-1 sector setting prior to takeoff. The F-4J has the LOW ANGLE sector setting control in the aft cockpit. The LABS sector settings are given in part 4 of this section.

Note

Each AN/AJB-7 ARBCS has angular error (deviation) which must be algebraically applied to the selected LABS sector setting. The instrument error is placarded on the gyro housing located in the aft cockpit.

LABS timer settings should be set and checked in the aft cockpit. The remainder of the airplanes should be set for a conventional weapons delivery to coincide with the desired releases and interval. As soon as possible and/or practical, the flight should be established on delivery heading, altitude and airspeed.

(U) IP to Pull-Up

(U) Passing over the IP, the pilot depresses the bomb release button which commences LABS timer run-down. One second prior to timer run-down, a brief warning tone alerts the pilot that pull-up is imminent.

WARNING

Do not depress the bomb release button with the AFCS engaged, the bomb control switch in LABS, and the aircraft in a bank attitude. The aircraft immediately rolls in the direction of the bank. The outer roll gimbal of the gyros is caged when the bomb button is depressed causing an erratic signal to the autopilot.

(U) Pull-Up to Release

(U) At expiration of the LABS timer setting, the LABS light illuminates, the steady LABS tone commences and the steering bars (G and Yaw/Roll needles) indicate deviations from the LOFT profile. Simultaneously with the latter indications, the pilot should smoothly apply military power while commencing a pull-up to apply 4 G in 2.0 seconds. The pilot should make every effort to keep the steering bars centered throughout the profile and weapon release.

(U) When the aircraft is at the pitch attitude set in the release angle computer, a release signal is generated, the LABS light goes out, the steady tone stops, the vertical needle moves out of view, and the first bomb is released. The pilot must continue to fly the 4.0 G pullup and keep the bomb button depressed until the last bomb is released. The horizontal needle remains sensitive to 4.0 G deviation until the bomb button is released; at this time the AJB-3, -7 returns to the function previously selected.

(U) Recovery or Reattack

(C) The wingover recovery can be modified as gross weight, size of formation, and enemy defenses dictate. Airspeed for maneuverability exists, and afterburner is available if needed. If a reattack has been planned, a nominal 27 seconds time of flight for the weapons from release to impact should be planned for. If a dive reattack is desired, afterburner may be necessary to continue climb subsequent to CONLABS release.

WARNING

Do not execute a roll-ahead recovery. A wingover recovery, effecting at least a 90° heading change, provides the best airplane-bomb separation. A roll-ahead recovery may cause airplane-to-bomb collision.

PART 4 WEAPON DELIVERY DATA

NOTICE

All Data contained in Part 4 is applicable to the F-4B, F-4J and F-4N except when noted.

BORESIGHTING

(U) REFERENCE LINES

(U) The aircraft reference lines used in this manual are illustrated and identified in figure 2-54.

(U) BORESIGHT PROCEDURES

(U) The parallel boresight procedures are presented in NAVAIR 01-245FDB-2-7. All sight angles and sight angle computations assume that the optical sight is parallel boresighted; i.e., the zero sight line is parallel to the fuselage reference line. The ground crew must perform the rough optical sight check after completing the boresight procedures. Upon completion of the Rough Optical Sight check (figure 2-56), the ground crew will placard the mil setting in a conspicuous and standardized location within the cockpit. This mil setting will be referred to as the Tagged Boresight Value.

(U) The F-4B MAC sight (before AVC 290) must be modified by painting out the SW placard on the sight depression knob and replacing it with 0. The sight must then be boresighted so that the zero sight line (ZSL) is parallel with the fuselage reference line (FRL). After this modification, the sight depression knob must be set on 35 mils when firing the Sidewinder missile. On the other two sights (figure 2-56), the ZSL is also parallel to FRL.

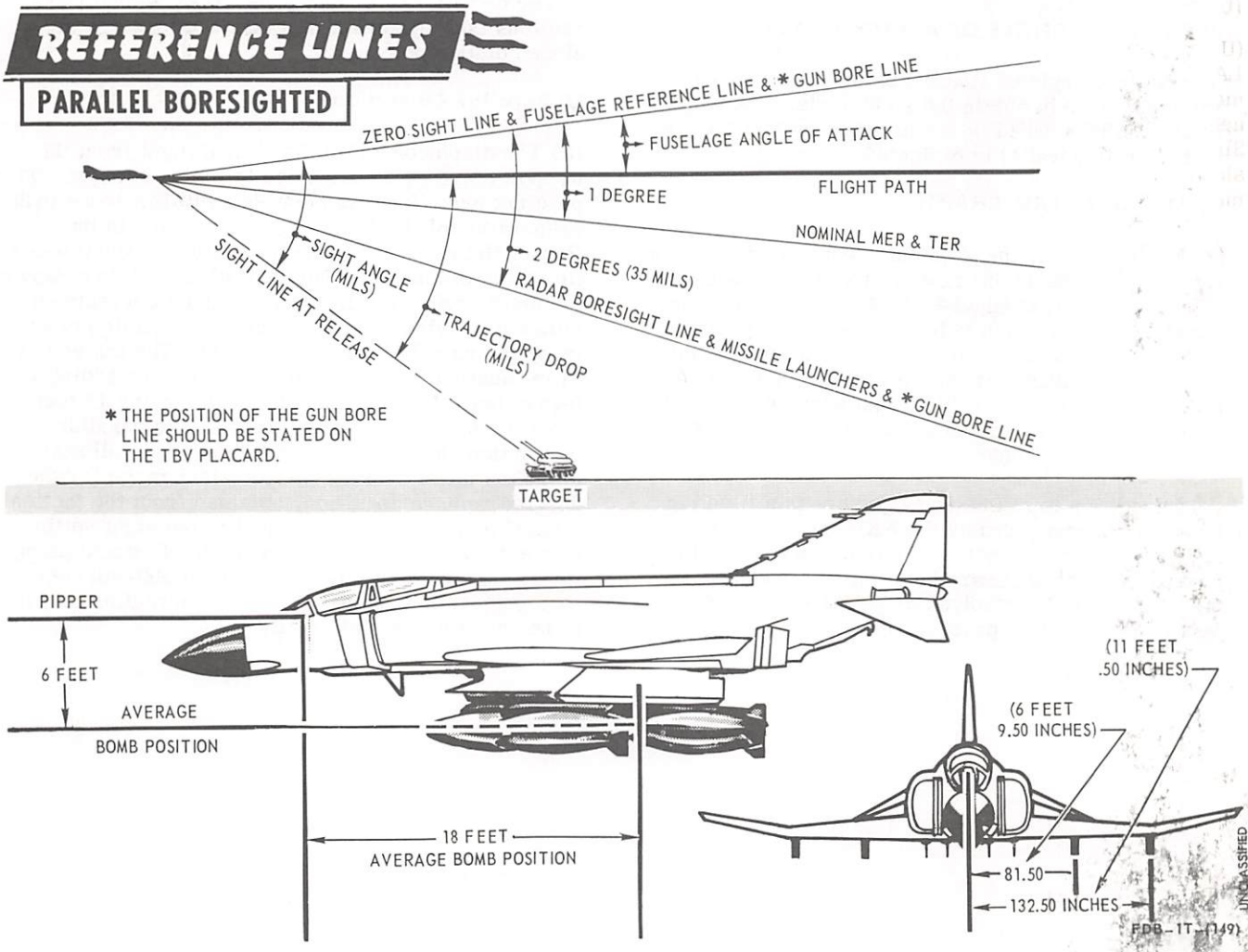


Figure 2-54 (U)

(U) The ground crew should indicate the nose gun attitude (0° or 2° down from FRL) on the same placard used for the Tagged Boresight Value. This is necessary to determine which set of sight settings should be used when firing the gun.

(U) Mini-Boresight Plate

(U) Figure 2-55 illustrates the use of the mini-boresight plate and provides dimensions for local manufacture. The mini-boresight plate should be used only when the aircraft can not be statically boresighted in accordance with the procedures in NAVAIR 01-245FDB-2-7. Experience has shown the accuracy of mini-boresight plate to be within ± 2 mils of the infinity boresight performed in accordance with NAVAIR 01-245FDB-2-7.

(U) ROUGH OPTICAL SIGHT CHECK

(U) The optical sight check is illustrated in figure 2-56. This sight check can be performed before take-off or during flight.

CHART DESCRIPTION

(U) GENERAL

(U) The following is a description of the charts that are applicable to all weapons and/or delivery modes.

(U) AIRSPEED CONVERSION CHART

(U) The airspeed conversion chart figure 2-62 is used to find calibrated airspeed, true Mach number, and true airspeed. Examples are provided on the chart.

(U) FUSELAGE ANGLE OF ATTACK CHART

(U) Fuselage angle of attack must be added to the trajectory drop to obtain the sight angle. The chart (figure 2-63) is based on the assumption that the optical sight is parallel boresighted.

(U) ALTIMETER LAG CHARTS

(U) During a dive, the altimeter does not unwind at a rate equal to the actual rate of aircraft descent. The altimeter lag chart (figures 2-64 and 2-65) provides the altitude correction to be applied to compute actual weapon release altitude. Two methods may be used to apply altimeter lag correction; adding to actual release altitude to obtain indicated release altitude, or subtracting from indicated altitude to obtain actual release altitude.

(U) In addition to altimeter lag, there is a time lag in a voice signal given by the RIO; and, there is time lag in the pilot's response, or reaction time. This type of time lag will vary between aircrews and therefore must be resolved by establishing a desirable communication procedure.

(U) SIGHT ANGLE CORRECTIONS

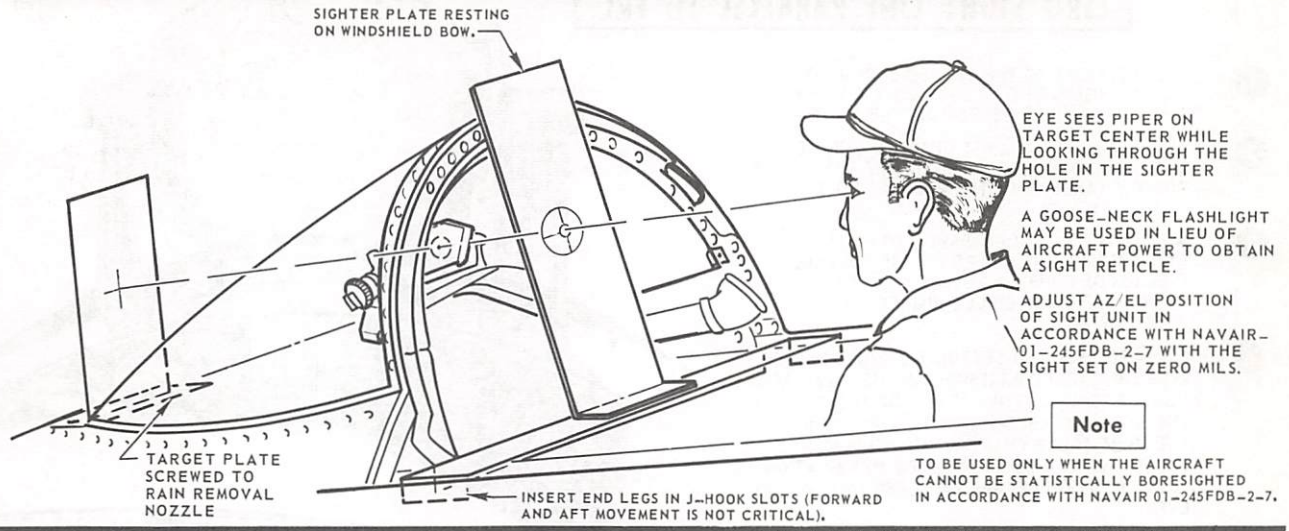
(U) Gross Weight Correction

(U) Since fuselage angle of attack is affected by aircraft gross weight, sight angles obtained from the Pocket Guide and the Sight Angle charts require correction for deviation from 42,000 pounds gross weight. Sight angle correction for deviation in aircraft gross weight from the standard 42,000 pounds can be determined by using the Gross Weight Corrections table (figure 2-66). Instructions are included on the table.

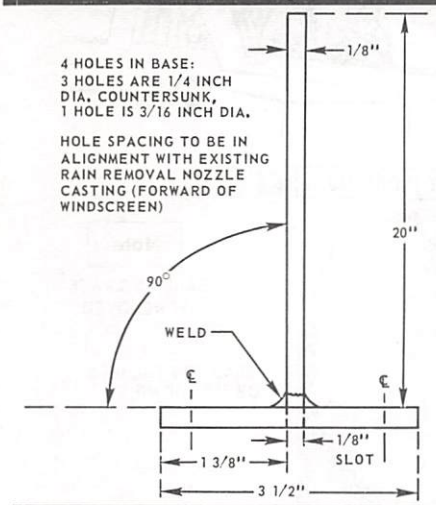
(U) Parallax Correction

(U) The displacement of the optical sight from the weapon requires a correction to the sight angle. This parallax error has been corrected and included in the preparation of the Sight Angle charts and in the Pocket Guide. When using the tactical manual ballistic tables presented in NAVAIR 01-1C-1T to compute the sight angle, parallax error can be corrected by either modifying the trajectory drop equation or by using the parallax correction chart. The trajectory drop equation (figure 2-60) is modified by adding 6 feet to the release altitude and subtracting 18 feet from the bomb down range travel. The parallax correction chart (figure 2-66) is used as follows: enter the chart with the weapon slant range for the desired release condition, obtained from the tactical manual ballistic tables, project to the sight setting (trajectory drop plus fuselage angle of attack) using linear interpolation between the 0 and 300-mil curves, then project down to establish the correction in mils to be added to the sight setting.

MINI BORESIGHT PLATE (PARALLEL BORESIGHT)



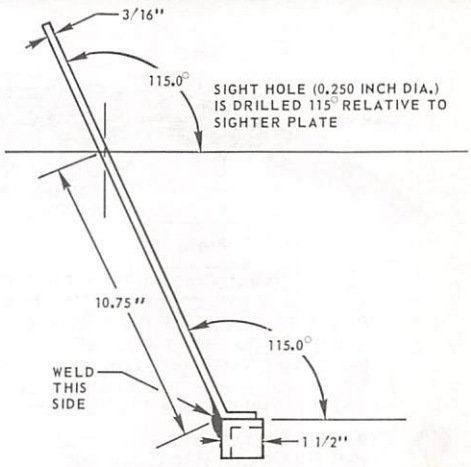
TARGET PLATE (OUTSIDE COCKPIT)

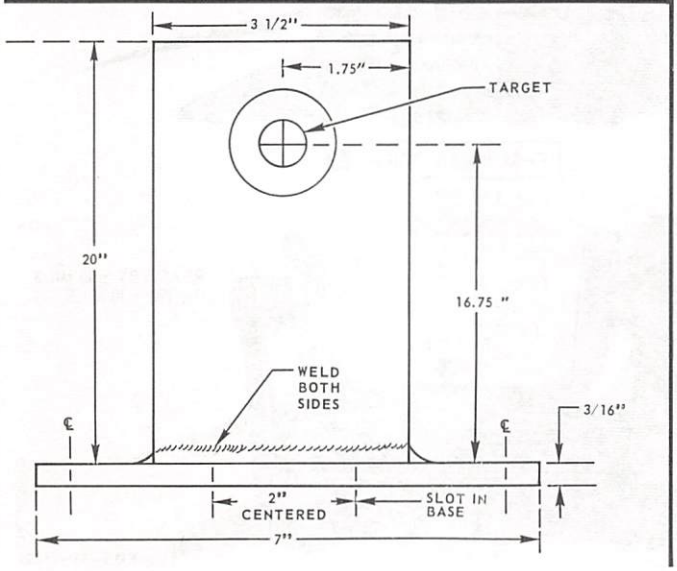


CONSTRUCTION NOTES

1. BUILD FROM AVAILABLE STOCK FOR EASE IN WELDING, EITHER STEEL OR ALUMINUM.
2. REMOVE SHARP EDGES AND BURRS.
3. FINISH: BRIGHT YELLOW (LESS TARGET/SIGHTER AREA).
4. AFTER COMPLETING CONSTRUCTION OF THE MINI BORESIGHT PLATE, CHECK THE LOCATION OF THE TARGET ON THE TARGET PLATE BY USING THE MINI BORESIGHT PLATE ON AN AIRCRAFT BORESIGHTED IN ACCORDANCE WITH NAVAIR 01-245FDB-2-7.
5. NOT DRAWN TO SCALE.

SIGHTER PLATE (INSIDE COCKPIT)





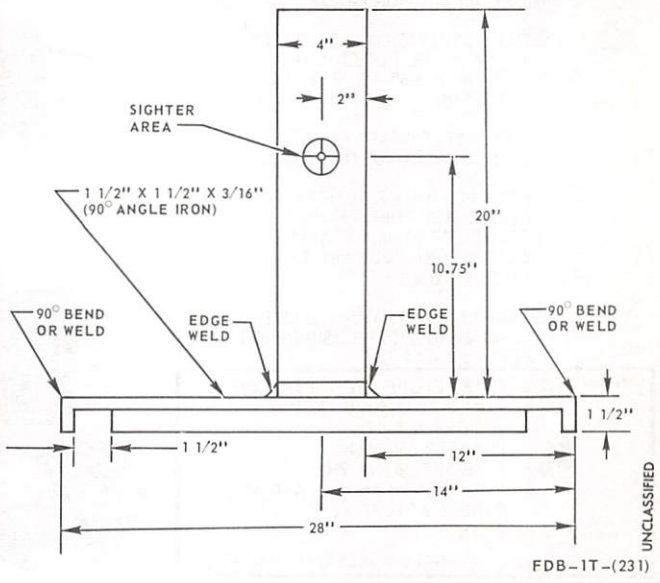
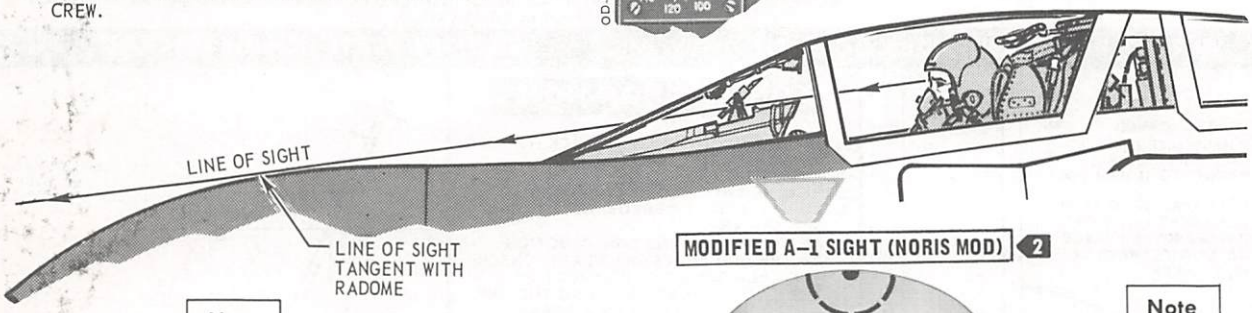


Figure 2-55 (U)

ROUGH OPTICAL SIGHT CHECK

ZERO SIGHT LINE PARALLEL TO FRL

1. DEPRESS SIGHT TO THE TAGGED BORESIGHT VALUE. OBSERVE NO AZIMUTH MOVEMENT BY THE PIPPER WHILE DEPRESSING THE SIGHT.
2. WITH HEAD BACK AGAINST HEADREST, CLOSE ONE EYE AND RAISE SEAT UNTIL THE REFERENCE POINT IS TANGENT TO THE RADOME. HOLD HEAD BACK AND:
3. ADJUST THE SIGHT DEPRESSION TO POSITION ONE-HALF OF THE PIPPER ON TOP FORWARD PORTION OF COMBINING GLASS WITH LOWER PORTION OF 25 MIL CIRCLE VISIBLE, AS ILLUSTRATED.
4. COMPARE THE SIGHT SETTING OBTAINED IN STEP 3 WITH THE TAGGED BORESIGHT VALUE (TBV). IF THE SIGHT SETTING IS WITHIN 10 MILS OF THE TBV, THE SIGHT IS USABLE WITHOUT CORRECTION TO THE SIGHT ANGLE CHART VALUE. THIS 10-MIL TOLERANCE CAN BE ATTRIBUTED TO VARIATION IN EYE POSITION BETWEEN AIRCREW AND GROUND CREW.



Note

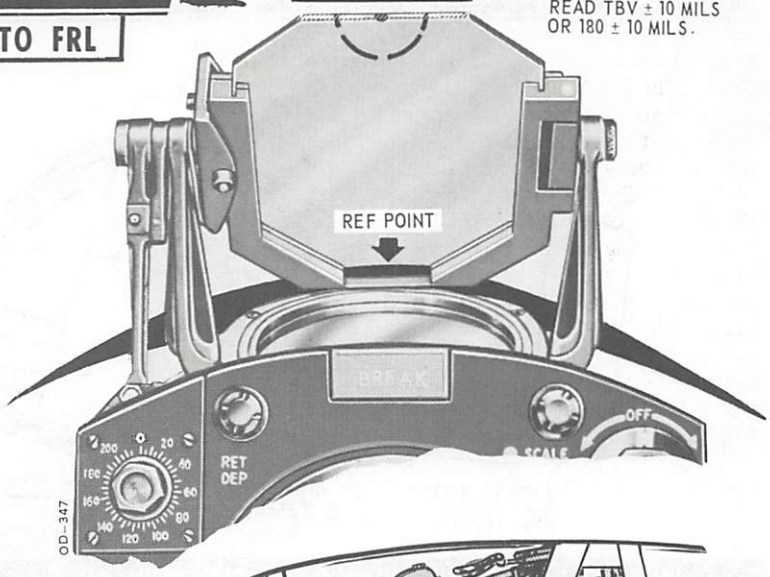
THE TAGGED VALUE ASSIGNED BY THE GROUND CREW, CAN BE EXPECTED TO BE 190 ± 10 MILS FOR ALL SIGHTS EXCEPT THE F-4B MAC SIGHT BEFORE AVC 290 WHICH SHOULD BE 180 ± 10 MILS. (THE TAGGED VALUE WILL NOT BE THE SAME FOR TWO AIRCRAFT). THE PILOT SHOULD OBTAIN ± 10 MILS OF THE TAGGED VALUE.

5. SMOOTHLY ROTATE THE SIGHT UP AND DOWN FULL TRAVEL TO CHECK FOR PIPPER DEFLECTION ERROR.
6. RETICLE DEPRESSION KNOB CHECK:
   a. WITH A 50-MIL RETICLE, SET 200 MILS. WITH A 60-MIL RETICLE, SET 240 MILS.
   b. PICK A STATIONARY POINT IN LINE OF SIGHT WITH TOP OF RETICLE.
   c. MOVE BOTTOM OF RETICLE TO STATIONARY POINT (50 MILS TRAVEL OR 60 MILS TRAVEL). DEPRESSION KNOB READ 150 MILS OR 180 MILS.
   d. REPEAT STEPS (b) AND (c) UNTIL SIGHT ZEROS. DEPRESSION KNOB READS ± 2 MILS.

Notes
1. ● F-4B BEFORE AVC 290 AND AVC 464.
   ● F-4J 153071z THRU 153799ac BEFORE AVC 498.
2. F-4B AFTER AVC 464.
3. ● F-4B AFTER AVC 290.
   ● F-4J 153800ad AND UP, AND ALL OTHERS AFTER AVC 498.
   ● F-4N.
4. TBV = TAGGED BORESIGHT VALUE.

F-4B MAC SIGHT 1

READ TBV ± 10 MILS OR 180 ± 10 MILS.

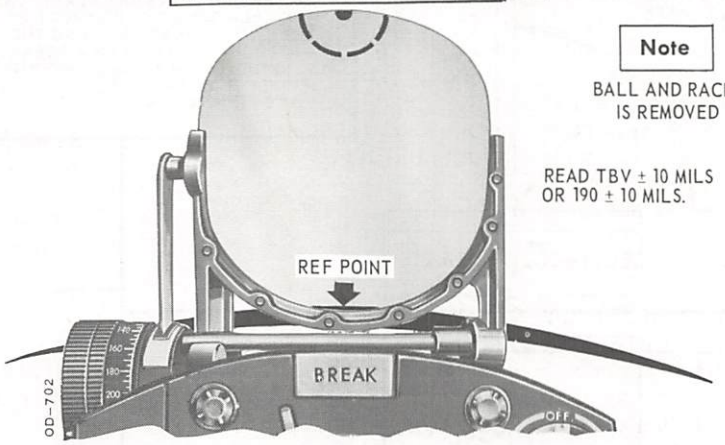


MODIFIED A-1 SIGHT (NORIS MOD) 2

Note

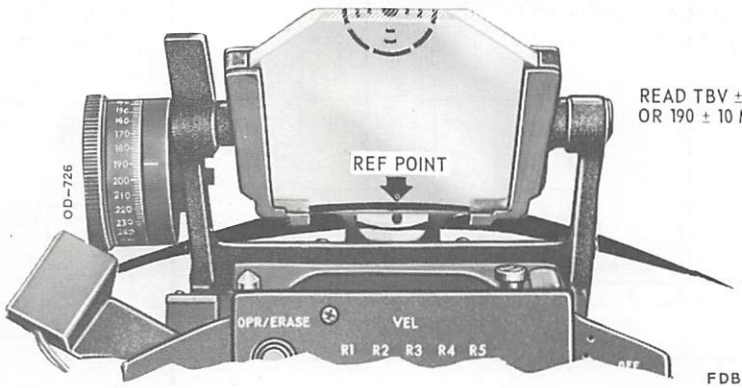
BALL AND RACE IS REMOVED

READ TBV ± 10 MILS OR 190 ± 10 MILS.



F-4J/N MAC SIGHT 3

READ TBV ± 10 MILS OR 190 ± 10 MILS.



UNCLASSIFIED

FDB-1T-(151)

Figure 2-56 (U)

(U) DIVE RECOVERY CHARTS

(U) The dive recovery charts (figure 2-67) can be used to establish the altitude lost during a 4.0 G or a 5.0 G wings-level pullout, or a 4.0 G breakaway turn. The data for 4.0 G breakaway turn are based on obtaining the G stated on the chart within 2 seconds after commencing pullup and do not include weapon release and pilot response times. The data in the 4.0 G and 5.0 G wings level pullup charts, in the Pocket Guide sight settings unsafe area, and in the Sight Angle charts recovery height tables is considered to be more representative of an actual flight profile, than the data given in the 4.0 G breakaway turn. The following assumptions were made in computing the data for the 4.0 G and 5.0 G wings level pullup charts, the recovery height tables on the Sight Angle charts, and the unsafe area in the Pocket Guide:

a. Straight-path, constant-velocity flight during weapon release,
b. A 1-second aircraft/pilot response delay time after weapon release during which aircraft maintains straight-path, constant-velocity flight,
c. A 100 percent MRT power setting initiated at the termination of the response-delay time (except for level delivery where the aircraft maintains straight and level, constant velocity flight after release),
d. A linear build-up to 4.0 G or 5.0 G in 1.25 seconds after termination of response-delay,
e. The charts are based on the indicated normal acceleration unless buffet on-set occurs. If buffet on-set occurs, the acceleration is relaxed such that the aircraft flies the buffet boundary. The 5.0 G Dive Recovery chart represents the altitude loss while flying the buffet boundary.
f. Bleed-off of G to attain a climb-out angle of 15 degrees above the horizontal.

(U) DIVE ACCELERATION CHARTS

(U) The Dive Acceleration chart (figure 2-68) is a plot of airspeed gained and altitude lost for a constant dive angle and power settings. The charts are computed for an aircraft gross weight of 42,000 pounds with a drag index of 60, ICAO standard day, and the following power settings: idle power, 88 percent power, and military power. The charts are based on representative entry altitudes for each dive angle presented. The vertical scale (altitude) is removed to eliminate the connotation that specific altitudes are assigned to the dive angle curves. The vertical scale represents altitude lost between two air speeds: entry and release airspeed. Each heavy horizontal graph line is equal to 1000 feet altitude lost. Variations between chart solution and actual condition can be attributed to variations in entry altitude, temperature, and drag index. The aircrew should establish improved entry parameters based on individual delivery technique. Examples are given on each chart for establishing the entry conditions.

(U) DIVE ANGLE/HORIZONTAL DISTANCE

(U) The Dive Angle/Horizontal Distance chart (figure 2-69) can be used to establish the pop-up entry maneuver parameters; see Pop-up Entry, part 3. The chart relates dive angle with horizontal distance, flight path slant range distance, and height (AGL). The chart can be used to approximate the slant range by entering the chart at the harp angle (dive angle plus mil sight setting in degrees) and the release height.

(U) AIRCRAFT DOWN RANGE TRAVEL AND ALTITUDE LOSS CHARTS

(U) The down range travel and altitude loss charts (figure 2-70) are used to determine two of the parameters used in the multiple release sight angle computation. One chart is prepared for each release intervalometer setting: 0.060 sec, 0.100 sec, and 0.140 sec. These charts are used to determine the distance that the aircraft travels in the horizontal and vertical plane during the time interval selected on the intervalometer. To determine the total distance traveled or total altitude loss during a multiple release, multiply the value obtained from the chart by one less than the total number of weapons released (N-1) for RIPPLE release. For CLUSTER release, use N-1 divided by 2.

(U) STRAFING DOWN RANGE TRAVEL AND ALTITUDE LOSS CHARTS

(U) The strafing down range travel and altitude loss charts (figure 2-71) are used to determine the distance traveled during a strafing burst of various duration and at 400, 450, 500 and 550 KTAS.

DELIVERY DATA DESCRIPTION

Note

- Computed delivery data (tabulated ballistic data, trajectory drop, bomb range and time of fall) can be obtained from the ballistic tables published in NAVAIR 01-1C-1T, Tactical Manual Ballistic Tables.
- Bomb time-of-fall is presented on the Sight Angle charts and in the Pocket Guide.

(U) GENERAL

(U) Delivery data charts and tables are provided for each weapon. The same figure number is used for all data applicable to the weapon, refer to table of contents, this section. Each weapon is illustrated and the weapon characteristics are outlined. Following the description of each weapon is a list of reference where detailed information and authorization pertaining to the employment of the weapon can be obtained.

(U) MAXIMUM FRAGMENT ENVELOPE CHARTS

(U) The Maximum Fragment Envelope charts show the fragment position relative to the weapon burst point as a function of time, and are used in determining the safe release interval between aircraft during multiple aircraft attacks. The charts are based on the assumption that the most hazardous fragment (i.e., the heaviest fragment with the maximum velocity) can be projected from the burst point at any angle, irrespective of weapon delivery conditions. Similar charts for rockets are given as a function of impact angle where the impact angle is approximately equal to the aircraft dive angle. The rocket envelopes may be rotated for consideration of launch angles other than those given. Refer to Safe Interval of Multiple Aircraft Attack, part 3.

(U) RELEASE ERROR SENSITIVITIES AND WIND CORRECTION

(U) The impact error that can be expected when the planned release conditions vary from the actual release conditions follows each weapon description in part 4 and are included in the Pocket Guide. The table illustrates the sensitivity of release airspeed (± 10 knots), release height (± 100 feet), dive angle (± 1°) sight angle setting (± 1 mil), sight angle deflection (1 mil left or right) for various dive angles, release heights, and release true airspeeds. Relative wind correction tables present the range error and crosswind error for each 10-knots of relative wind. Impact error is in feet, (+) long or (-) short of the target. Wind correction is presented in feet and in mils.

(U) SIGHT ANGLE CHARTS AND POCKET GUIDE SIGHT SETTINGS

(U) The Sight Angle charts for a single weapon release provide sight angles in mils for various dive angles, release heights, release airspeeds. For multiple release, refer to figure 2-60 and to the Pocket Guide. The sight settings obtained from the Sight Angle charts and the Pocket Guide includes parallax correction. Sight angle corrections for deviations in aircraft gross weight from the standard 42,000 pounds are presented in the Pocket Guide and figure 2-66, Sight Angle Corrections. The stated ejection velocity used for each weapon, is based upon the size of the ejector rack cartridge, the weight of the store, and average position of the weapon on the MER/TER. The time-of-fall curves are in 2-second intervals. Time of fall is presented in the Pocket Guide for the last bomb released. The unsafe areas shown in the Pocket Guide are for terrain avoidance or fragment envelope. The curves in the Sight Angle charts terminate at the terrain avoidance curve or at the 0.010 fragment risk probability curve. Lesser hit probability are included and identified: 0.001 and 0.000. Since the minimum release height may be difficult to read on the chart, a table is printed below each chart to identify the fragment risk and recovery height. Sight angle charts are based on the following assumptions:

a. Target at sea level.
b. No wind.
c. Air temperature, gravity, and density variation with geometric altitude as defined in the U.S. Standard Atmosphere, 1962.
d. Aircraft weight of 42,000 pounds.
e. One knot true airspeed equals 1.6878 feet per second.

(U) The minimum release height and related recovery height for a given weapon and release speed is based on the following assumptions:

a. Single weapon release to place on target one bomb, one fire bomb, the center of a rocket pod, or the center of one CBU dispenser tube.
b. Instantaneous ground detonation (zero altitude).
c. Maximum probability of one-or-more fragment hits on the delivery aircraft considering a ± 10° deviation from the normal weapon trajectory angle at detonation.
d. An aircraft recovery maneuver based on the assumptions given in the 4 G Dive Recovery Chart description.

e. The more restrictive of the following:

(1) Prescribed hit probability.
(2) Aircraft recovery height above target by the following amounts:

Dive Angle (Deg)	Recovery Height (Ft)
0	100
10	200
20	300
30	500
40 to 45	700
50 to 60	1000

(U) Aircraft altitude loss from weapon release to recovery can be determined by differencing release height and recovery height (terrain avoidance) or by referring to the Dive Recovery Chart figure 2-67. In some cases, identical release/recovery heights are given for different fragment hit probability levels for an indicated dive angle/airspeed combination. This is due to the following:

a. Terrain avoidance precludes aircraft penetration of fragment envelope.
b. Round-off to nearest 25 feet: down if less than or equal to 5 feet, up if greater than 5 feet.

WARNING

- Variations from the above assumptions and the release restrictions specified on the sight angle charts may significantly change the release altitudes required to avoid weapon fragments.

- The weapons may not be cleared for release at all delivery conditions specified in the sight angle charts and Pocket Guide. Refer to Fuzing, part 1 for fuze operating limitations. Refer to appendix A for external store limitations.

(U) Pocket Guide

(U) The Tactical Manual Pocket Guide, NAVAIR 01-245FDB-1T(B) is not distributed automatically with this manual, and therefore, must be ordered as a separate publication. The pocket guide is printed on cardstock and is designed to be fastened to the knee pad. The pocket guide contains the essential data required to provide inflight flexibility during air-to-ground, non-nuclear weapon delivery mission. The charts and sight angles are based on data obtained from this section. The switch positions for release and jettison of each weapon are presented for ready reference. The RELEASE UNSAFE area (height and TAS) is represented by diagonal lines to establish the frag hazard or by a solid black area where terrain avoidance is the limiting factor based on 4.0 G pullout. All multiple release sight angles are for first bomb off to place the center bomb on target when the last bomb is released at the stated last bomb release height with an interval setting of 140 milliseconds and aircraft gross weight of 42,000 pounds (figure 2-57). The time-of-fall (TF) and release height is for the last bomb off. The pilot must determine the first bomb release height by using the Down Range Travel and Altitude Loss charts. Space is provided at the bottom of each sight angle table for the aircrew to write in the latest release and jettison limitation obtained from Appendix A of this manual. Use the pocket guide Table of Contents.

(U) CBU-24, -29, -49 PATTERN AND ARMING

(C) The pattern diameter and fuze arming requirements of the CBU-24, -29, and -49 dispenser are presented in CBU-24, -29 and -49 Pattern and Arming charts. The following data are presented.

a. Minimum release altitude to assure M907 fuze function and assure BLU-26/B arming.
b. Impact pattern diameter.
c. M907 fuze setting for the desired BLU-26/B pattern diameter.

(C) The bomblet pattern and arming charts indicate the expected impact pattern diameter for release altitudes to 8000 feet AGL. A separate chart is presented for the following dive angle and airspeed combinations:

a. Level release at 400, 500 and 600 knots TAS.
b. 15° dive release at 400, 500 and 600 knots TAS.
c. 30° dive release at 400, 500 and 600 knots TAS.
d. 45° dive release at 400, 500 and 600 knots TAS.

(C) The ARMING LIMIT line on the charts indicates the minimum M907 fuze setting or minimum release altitude that is required to assure BLU-26/B arming. The arming limit also considers ± 1-second functioning tolerance of the M907 fuze settings. The limit line is based on the assumption that the fuze will function 1 second late.

Note

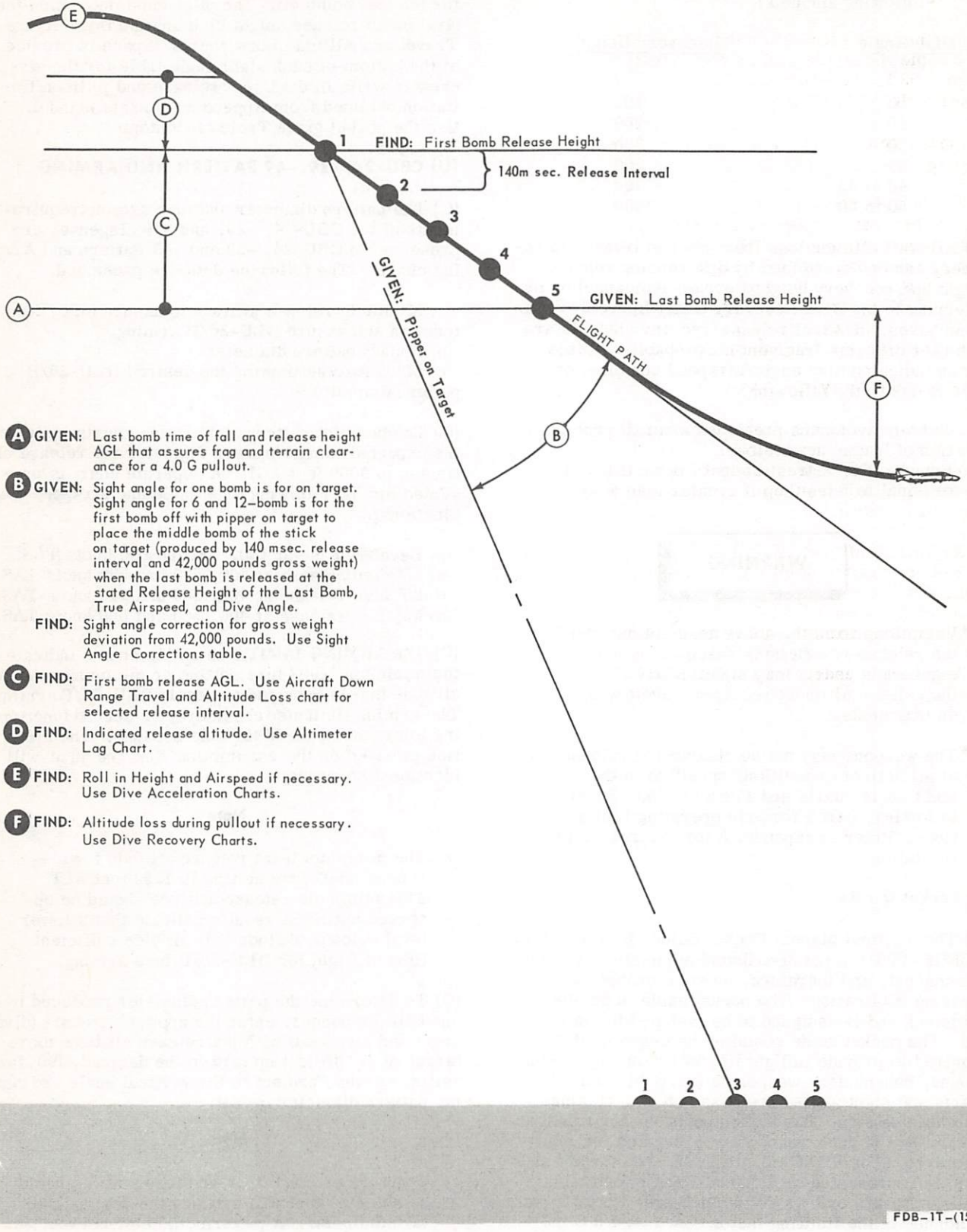
The minimum level release altitude for a 4-second M907 fuze setting is 1250 feet AGL. This minimum release altitude should be observed until test results indicate that a lower level release altitude will provide sufficient time of flight for BLU-26/B fuze arming.

(C) To determine the pattern diameter produced by one CBU dispenser, enter the applicable chart (dive angle and airspeed) with the release altitude above target AGL, project upward to the desired M907 fuze setting curves, project to the vertical scale and read the pattern diameter in feet.

Note

The release conditions and fuze setting should be selected that will produce the desired pattern diameter. A pattern diameter between 700 and 900 feet is considered to produce the most effective results.

USING THE POCKET GUIDE



A GIVEN: Last bomb time of fall and release height AGL that assures frag and terrain clearance for a 4.0 G pullout.

B GIVEN: Sight angle for one bomb is for on target. Sight angle for 6 and 12-bomb is for the first bomb off with pipper on target to place the middle bomb of the stick on target (produced by 140 msec. release interval and 42,000 pounds gross weight) when the last bomb is released at the stated Release Height of the Last Bomb, True Airspeed, and Dive Angle.

FIND: Sight angle correction for gross weight deviation from 42,000 pounds. Use Sight Angle Corrections table.

C FIND: First bomb release AGL. Use Aircraft Down Range Travel and Altitude Loss chart for selected release interval.

D FIND: Indicated release altitude. Use Altimeter Lag Chart.

E FIND: Roll in Height and Airspeed if necessary. Use Dive Acceleration Charts.

F FIND: Altitude loss during pullout if necessary. Use Dive Recovery Charts.

Figure 2-57 (U)

This page is UNCLASSIFIED

(U) Linear interpolation between airspeeds may be used to determine the minimum release altitude and impact pattern diameter for intermediate airspeeds.

(U) ROCKEYE II IMPACT PATTERN

(C) The minimum time from dispenser open to MK 118 bomblet impact should be 3 seconds. Refer to figure 2-93 Impact Patterns of one Rockeye II Dispenser with MK 339 Fuze.

(U) BOMB SPACING DURING MULTIPLE RELEASE CHARTS

(U) The bomb spacing charts provide the horizontal distance between two weapons released at a given interval and from a given height AGL. To determine the pattern length, multiply the value obtained from the chart by the number of weapons released minus one bomb (N-1) for RIPPLE release. For CLUSTER release, use N-1 divided by 2. Refer to Suspension Equipment, Normal Operation, part 1.

(U) CONLABS DELIVERY DATA

(U) The CONLABS delivery data presented in figures 2-100 thru 2-102 is explained in CONLABS Sample Problem and illustrated in figure 2-61. The data is based on and includes the following standard conditions/parameters:

a. F-4B aircraft with J79-GE-8 engines.
b. F-4J aircraft with either J79-GE-8 or J79-GE-10 engines.
c. Aircraft gross weight 42,000 pounds.
d. Pullup acceleration, 4.0 G in 2 seconds to buffet onset.
e. Approach speeds, 450 and 500 KTAS.
f. Approach altitude, 100 feet AGL.
g. Target elevation, sea level.
h. ICAO Standard Day atmosphere.
i. Release angle of first bomb; 20°, 30°, and 45°.
j. Ripple release interval; 60, 100, and 140 milliseconds.

(U) CONLABS Charts and Tables

a. CONLABS Pullup to Impact Distance, figure 2-100:

MK 76 MOD 5 Practice Bomb (-8 engine).
MK 76 MOD 5 Practice Bomb (-10 engine).
MK 81 LDGP (-8 engine).
MK 81 LDGP (-10 engine).
MK 81 Snakeye Unretarded (-8 engine).
MK 81 Snakeye Unretarded (-10 engine).
MK 82 LDGP (-8 engine).
MK 82 LDGP (-10 engine).
MK 82 Snakeye Unretarded (-8 engine).
MK 82 Snakeye Unretarded (-10 engine).
MK 83 LDGP (-8 engine).
MK 83 LDGP (-10 engine).
M117A1 Bomb with M131 Fin (-8 engine).
M117A1 Bomb with M131 Fin (-10 engine).

b. CONLABS Wind Offset Components, figure 2-101.
c. CONLABS Corrections, figure 2-102

MK 76 MOD 5, Practice Bomb.
MK 81 LDGP.
MK 82 LDGP.
MK 83 LDGP.
MK 81 Snakeye Unretarded.
MK 82 Snakeye Unretarded.
M117A1 Bomb with M131 Fin.

SAMPLE PROBLEMS AND COMPUTATIONS

(U) WIND CORRECTION COMPUTA – TIONS

(U) The Release Error Sensitivities and Wind Correction tables provide a relative wind correction value in feet per 10 knots of wind. This value is the product of the bomb time of flight in seconds, times 1.7 times 10. The relative wind value is used to relocate the aim point up-wind from the target to correct for the total wind effect. Refer to figure 2-58. For the higher release altitudes, the wind at the release altitude should be used since the wind at release will have the greatest effect on the impact accuracy. For the lower release altitudes, the surface wind can be used. The up-wind aim point can be approached from any direction. This method of wind correction further assumes that the bomb is released at the planned release conditions and with the no-wind sight angle. The pipper should be on the aim point when release occurs. The up-wind aim point technique can be employed for dive bombing and level bombing with either high drag or low drag bombs, rockets, and guns.

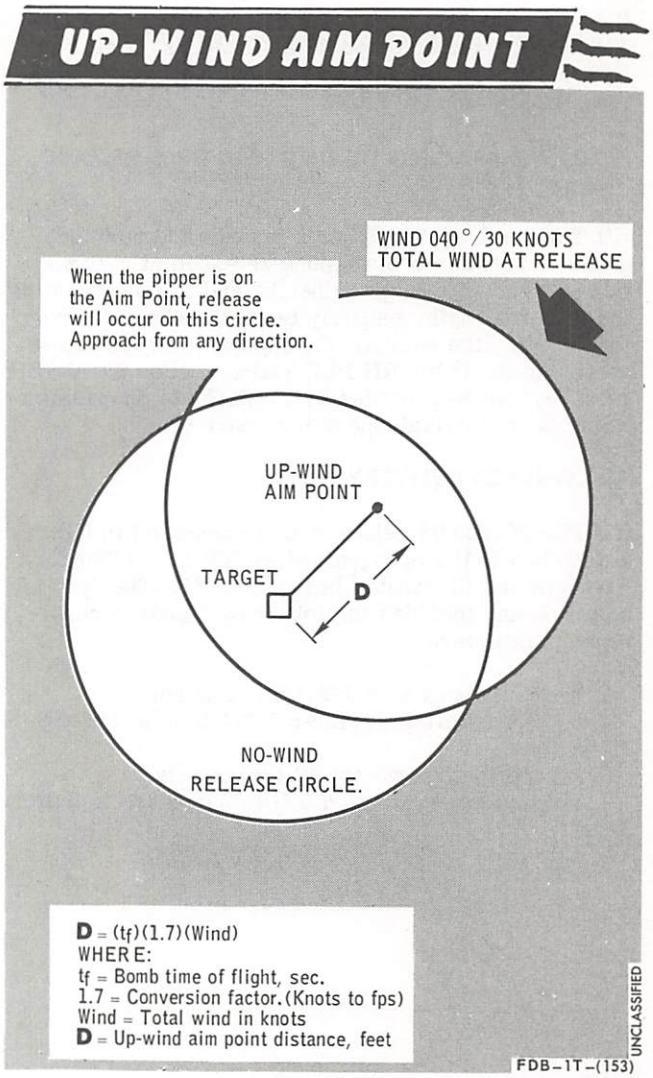


Figure 2-58 (U)

(U) SIGHT ANGLE COMPUTATIONS

(U) SINGLE BOMB RELEASE

(U) The following formula will produce a close approximation to a sight angle for a given release airspeed, height, dive angle, and fuselage angle of attack:

Angle of Attack + Trajectory Drop + Parallax = Sight Angle.

(U) Sample Problem

(U) Release Conditions: MK 81 Snakeye (Retarded), 10° Dive, 450 KTAS, 600 ft., 38,000 pounds, ICAO Standard Day temperature and pressure.

1. Fuselage Angle of Attack (figure 2-63):	12 mils
2. Trajectory Drop in mils (obtained from NAVAIR 01-1C-1T):	131
3. Add items 1 and 2, then use figure 2-66 to obtain parallax:	4 mils
4. Total for Sight Angle (Add items 1, 2 and 3):	147 mils

(U) ROCKET FIRING AND GUN FIRING (MK 4 GUN POD)

NEW (U) Figure 2-59 illustrates the data and format available in NAVAIR 01-1C-1T. The sight settings include angle of attack and parallax correction. The only correction necessary is for gross weight when other than the standard 42,000 pounds. This is accomplished by a constant multiplier as explained in NAVAIR 01-1C-1T.

DELIVER DATA SAMPLE FROM NAVAIR 01-1C-1T

NAVAIR 01-1C-1T

DELIVERY DATA

F-4 AIRCRAFT

2.75-INCH FFAR/WARHEADS MARK 1&5 AND MODS

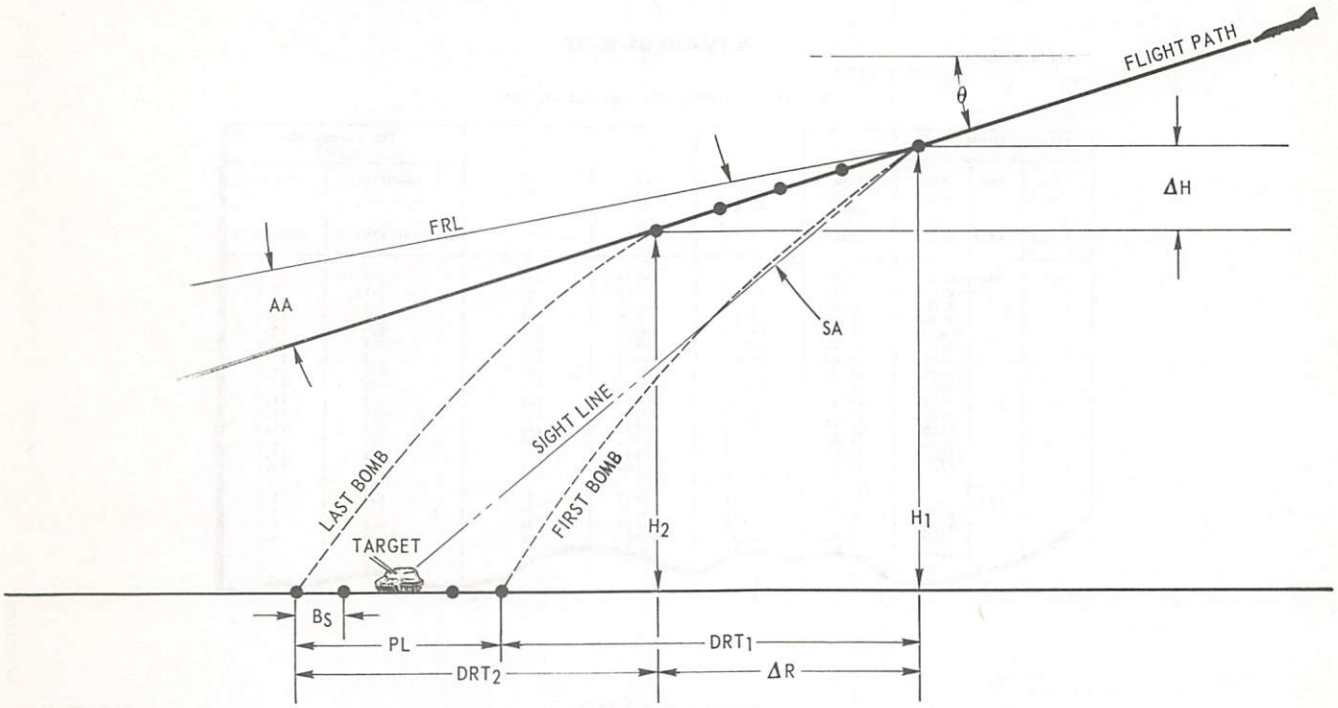
RELEASE CONDITIONS			TIME OF FALL	RANGE OF TARGET	SLANT RANGE	SIGHT SETTING	WIND CORRECTION FACTORS	
DIVE ANGLE (DEG)	TAS (KTS)	ALT (AGL) (FT)	(SEC)	(FT)	(FT)	(MIL)	HEAD/TAIL (MIL/10KT)	CROSS (MIL/10KT)
-30	400	8000	8.40	12330	14698	83	5.2	9.6
		8500	9.10	12987	15521	88	5.4	9.9
		9000	9.81	13627	16330	93	5.6	10.1
		9500	10.53	14250	17126	98	5.8	10.4
		10000	11.24	14858	17909	104	5.9	10.6
		10500	11.96	15450	18680	109	6.1	10.8
		11000	12.67	16028	19440	115	6.2	11.0
		11500	13.39	16593	20188	120	6.4	11.2
		12000	14.10	17144	20927	126	6.5	11.4
		12500	14.81	17689	21660	132	6.7	11.5
		13000	15.51	18217	22380	138	6.8	11.7
		13500	16.21	18735	23092	144	6.9	11.8
		14000	16.90	19242	23796	149	7.1	12.0
		14500	17.59	19741	24494	155	7.2	12.1
		15000	18.27	20237	25190	161	7.3	12.2
	450	2000	1.93	3311	3868	34	4.4	8.4
		2350	2.18	3878	4534	35	4.2	8.1
		2500	2.29	4120	4819	36	4.2	8.0
		2600	2.36	4281	5008	36	4.1	8.0
		3000	[illegible]	[illegible]	[illegible]	38	4.1	7.8
		3500					4.0	7.8
		[illegible]						7.8

UNCLASSIFIED

Figure 2-59 (U)

FDB-IT-(242)

SIGHT ANGLE FOR MULTIPLE & SINGLE RELEASE



AA Fuselage Angle of Attack - MILS

DRT_1 Down Range Travel of first bomb - FEET = DRT_2 + ΔR - PL

DRT_2 Down Range Travel of last bomb - FEET (From NAVAIR-01-1C-1T Ballistic Table)

FRL Fuselage Reference Line.

H_1 Release Altitude of First Bomb = H_2 + ΔH

H_2 Release Altitude of Last Bomb (From NAVAIR-01-1C-1T Ballistic Table)

PL Pattern Length (Stick length) - FEET = B_S (N-1)

SA Sight Depression Angle - MILS = $\left(\arctan \frac{H_1}{DRT_1 + \frac{PL}{2}} - \theta\right)(17.45) + AA + P$

P Parallax from Sight Angle Correction Chart, part 4.

Note

For a Single Bomb Release:

$$SA = \left[\left(\arctan \frac{H}{DRT} - \theta\right)(17.45)\right] + AA + P$$

θ Dive Angle - DEGREES

ΔH Altitude Difference Between the First and Last Bomb Release Point

ΔR Horizontal Range Difference Between the First and Last Bomb Release Point

B_S Bomb Spacing - FEET (Refer to applicable Bomb Spacing Chart)

N-1 Number of bombs released minus one bomb.

UNCLASSIFIED

FDB-1T-(155)

Figure 2-60 (U)

(U) MULTIPLE BOMB RELEASE

(U) For both low and high drag bombs, the difference between single bomb release sight setting and multiple bomb release sight setting may often be significant and is dependent on the release interval and dive angle which affects the stick length. Refer to pocket guide NAVAIR 01-245FDB-1T(B) for 1, 6 and 12-bomb stick sight settings.

Note

The Pocket Guide NAVAIR 01-245FDB-1T(B) contains the sight settings for 1, 6, and 12 bomb sticks. The sight settings are computed to place the middle bomb on target. Release heights and times of fall are for the last bomb off.

(U) Sample Problem

(U) RELEASE CONDITIONS:

1. Dive Angle	30 degrees
2. Release True Airspeed	450 knots
3. Release Intervalometer Setting	100 milliseconds
4. Number of M117A1 Bombs Released	4
5. Release Height Above Target Of Last Bomb (H_2)	5000 feet
6. Down Range Travel Of Last Bomb (Obtained From NAVAIR 01-1C-1T, Tactical Manual Ballistic Tables), (DRT_2)	6086 feet

Note

Standard ICAO Atmosphere, 45,000 lbs gross weight.

(U) FIND Δ R

7. Find the down range travel (horizontal distance that the aircraft travels during one release interval), figure 2-70 sheet 2.	66 feet
8. Subtract one bomb from the number of bombs to be released.	3
9. Multiply item 7 by item 8 to obtain the horizontal distance that the aircraft travels from the first to last bomb release. (Δ R)	198 feet

(U) FIND Δ H

10. Find the altitude lost (the vertical distance that the aircraft travels during one release interval), figure 2-70, sheet 2.	38 feet
11. Subtract one bomb from the number of bombs to be released	3
12. Multiply item 10 by item 11 to determine Δ H	114 feet

(U) FIND PATTERN LENGTH (PL)

13. Select the applicable bomb spacing chart: Dive Angle, item 1; Release true airspeed, item 2; Intervalometer setting, item 3; and last bomb release height, item 5.	30 feet
14. Multiply item 13 by item 11 to determine the pattern length (PL).	90 feet

(U) FIND RELEASE ALTITUDE OF FIRST BOMB, (H_1)

15. Add item 5 to item 12, ($H_1 = H_2 + \Delta$ H)	5114 feet

(U) FIND DOWN RANGE TRAVEL OF FIRST BOMB (DRT_1)

16. Add item 6 to item 9, and subtract item 14, ($DRT_1 = DRT_2 + \Delta$ R-PL) 6194 feet

(U) FIND FUSELAGE ANGLE OF ATTACK (AA)

17. Fuselage Angle Of Attack, Figure 2-63 16 mils

(U) FIND THE OPTICAL SIGHT SETTING, (SA)

$$SA = (ARCTAN \frac{H_1}{DRT_1 + PL/2} - \theta)\ 17.45 + AA + P$$

18. Divide: H_1 by the quantity $DRT_1 + PL/2$, item 15, divided by, item 16 plus one half item 14) 0.81968

19. Find the arctan of item 19, (trigonmetric tables are not provided). 39.34 degree

20. Multiply item 19 minus the dive angle, item 1, by 17.45 to convert degrees to mils. 163 mils

21. Add the fuselage angle of attack, item 17, to item 20 to obtain optical sight setting. 179 mils

22. Obtain the parallax correction from figure 2-66. 1 mil

23. Add the fuselage angle of attack, item 17, to item 20, then add item 22 to obtain the total optical sight setting. 180 mils

(U) CONLABS SAMPLE PROBLEM

(U) To illustrate the use of the planning procedures, the following sample problem is supplied. Refer to figure 2-61, CONLABS Planning Profile.

1. Begin computation with:

   a. The lead aircraft will loft six MK 81 LDGP bombs from an F-4J aircraft with a J79-GE-10 engine.
   b. The bombs will be mechanically fuzed with M904E2 fuzes.
   c. The target is a SA-2 site with an elevation of 3000 feet and due to hilly terrain a run-in height above target of 500 feet is chosen.
   d. The IP to target distance is 25,000 feet. The IP is a lighthouse selected due to prominence and accurate chart positioning.

2. Use CONLABS tabulated data figure 2-100 for the MK 81 LDGP Bomb to determine the stick length (last bomb off minus first bomb off).

Note

The weapon destructive radius should be used as a guide in determining what interbomb spacing to use.

3. The weapons delivery parameters are as follows:

a. Approach speed	450 KTAS
b. Initial Release Angle	20°
c. Number of Weapons	6
d. Intervalometer Setting	100 ms
e. Target Elevation (MSL)	3000 ft
f. Aircraft Gross Weight	40,000 lbs
g. Target Temperature	19° C
h. Approach Altitude (AGL)	500 ft
i. Time to reach 4 G	2 sec
j. Release altitude wind direction and speed	040°/50 KTS
k. No wind heading	010°

4. From CONLABS tabulated data figure 2-100 obtain:

a. LABS Sector Setting	28.43°
b. First Weapon Pullup-To-Impact Distance	14,002 ft
c. Last Weapon Pullup-To-Impact Distance	15,691 ft

5. To obtain stick length subtract the first weapon pullup-to-impact distance from the last weapon pullup-to-impact distance.

   Stick Length = 15,691 - 14,002 = 1689 ft

6. Using the data given in figure 2-102, determine the corrections for variation from standard conditions. The variation is determined by subtracting standard from non-standard. The standard conditions are listed under the title, CONLABS Delivery Data. NEW

Note

For temperature corrections use a standard lapse rate of 2°C/1000 ft of altitude and a sea level temperature of 15°C. Therefore the standard temperature at the 3000 ft MSL target is approximately 9°C.

a. (19°C - 9°C) = +10°C increase in temperature . . . . . -121 ft

b. (3000 ft - 0 ft) = +3000 ft increase in target elevation . . . . . -135 ft

c. (40,000 lb - 42,000 lb) = -2000 lb decrease in aircraft gross weight . . . . . +144 ft

d. (500 ft - 100 ft) = +400 ft increase in approach altitude . . . . . +588 ft

e. Total correction equals items a + b + c + d . . . . . +476 ft

7. Corrected pullup-to-impact distance for first weapon off equals item 4 (b) plus item 6 (e).

   Corrected pullup-to-impact distance = 14,002 +476 = 14,478 ft

8. The location of the center of stick from pullup point equals item 7 plus one half item 5.

   Center of stick pullup distance = 14,478 + 1/2 (1689) = 15,322 ft

Note

A negative value for stick length will occur when using an initial release angle of 45°, hence item 8 will be less than item 7.

9. The no wind LABS timer setting is equal to the IP-to-target range minus item 8 divided by the run-in speed in ft/sec (450 KTAS = 759 ft/sec) and (500 KTAS = 843 ft/sec).

   LABS Timer setting = (25,000 - 15,322)/759 = 12.8 sec

10. The recommended procedure for correcting for a known release altitude wind is to displace the pullup point into the wind; use wind correction factors (figure 2-102). Total offset into the wind equals wind in knots times wind correction factor.

    a. Total offset into the wind . . . . . 50 KTS x 42 = 2100 ft

    Use items 3 (j), 3 (k) and 10 (a) with figure 2-101.

    b. Range component of wind offset . . . . . 1825 ft

    c. Deflection component of wind offset . . . . . 1100 ft

(U) The range component is compensated for by the LABS timer. The deflection component is compensated for by use of an offset IP (figure 2-61). Pullup is made with the aircraft heading in the no wind run-in direction.

11. LABS timer adjustment for wind is the range component of wind offset in feet (item 10 (b)) divided by the run-in speed in ft/sec.

12. Corrected LABS timer setting with winds equals item 9 plus item 11 for a headwind (minus item 11 for a tail wind).

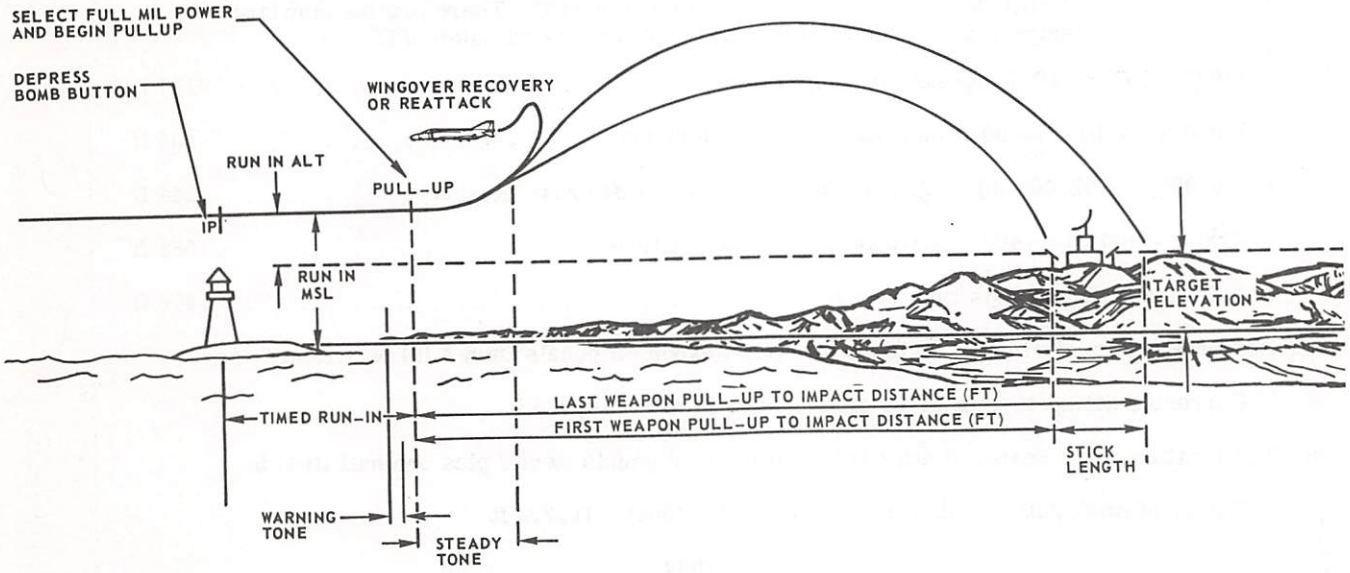
    Corrected LABS timer setting = 12.8 + 2.4 = 15.2 sec

13. For fuze arming time consideration, the minimum weapon time of flight for all CONLABS release is 16 seconds. Refer to Minimum Authorized Arming Times and Speeds, figure 2-10.

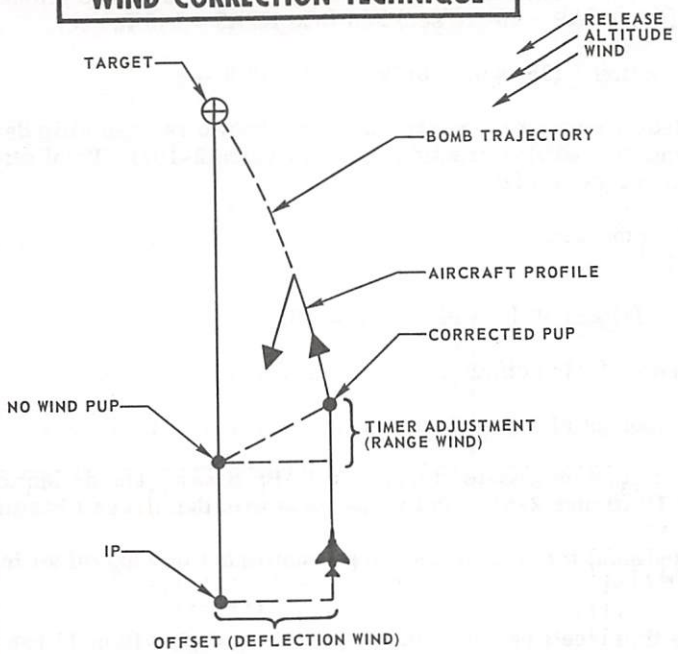
CONLABS PLANNING PROFILE

Note

A NEGATIVE VALUE FOR STICK LENGTH WILL OCCUR WHEN USING AN INITIAL RELEASE ANGLE OF 45°.



WIND CORRECTION TECHNIQUE

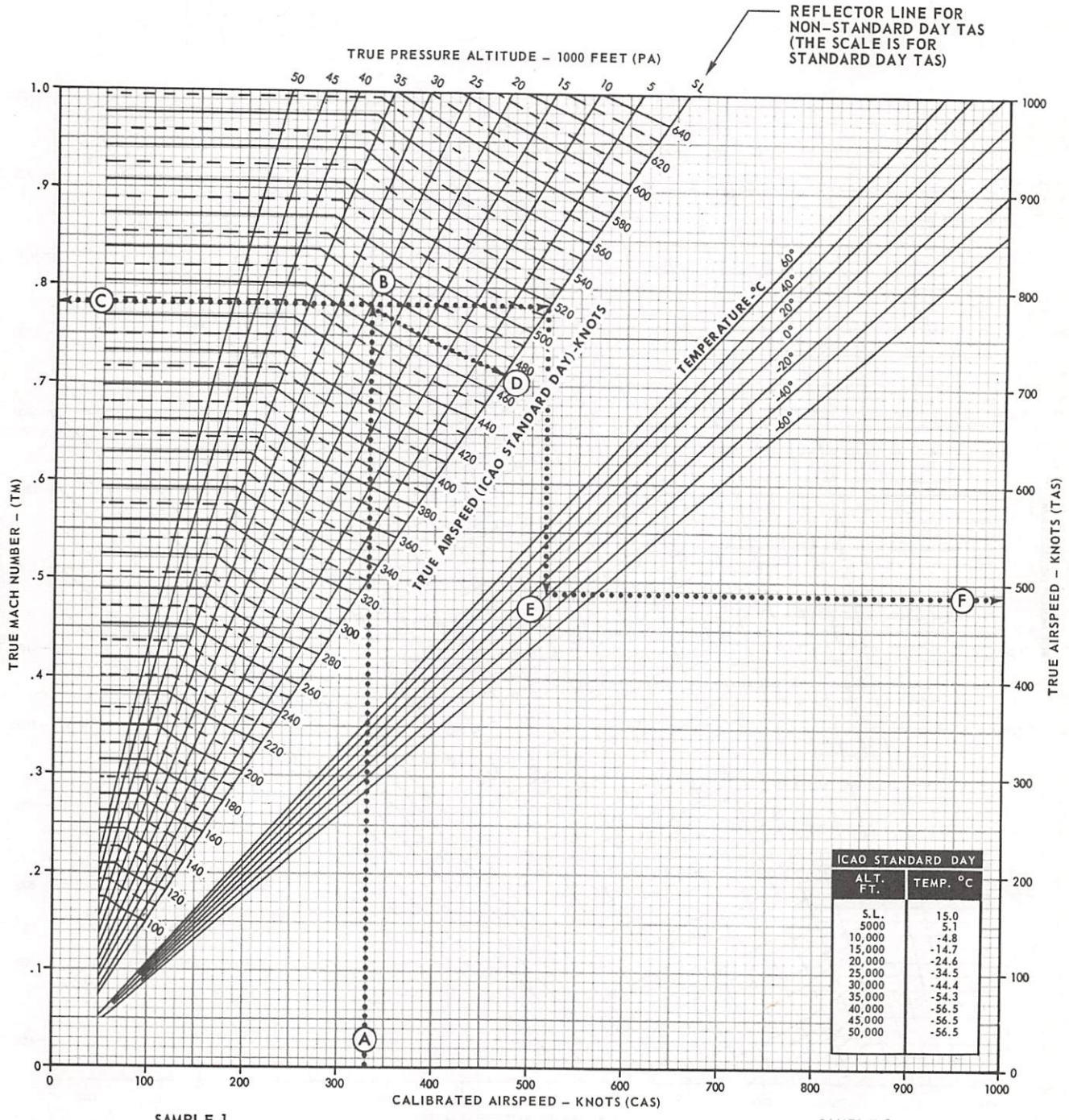


UNCLASSIFIED

FDB-1T-(156)

Figure 2-61 (U)

AIRSPEED CONVERSION



ICAO STANDARD DAY	
ALT. FT.	TEMP. °C
S.L.	15.0
5000	5.1
10,000	-4.8
15,000	-14.7
20,000	-24.6
25,000	-34.5
30,000	-44.4
35,000	-54.3
40,000	-56.5
45,000	-56.5
50,000	-56.5

SAMPLE 1

CAS to TM to TAS (S.D.) to TAS			
A	CAS		330
B	PA		25,000
C	TM	is	0.78
D	TAS (S.D.)	is	470
E	TEMP		–20
F	TAS	is	485

SAMPLE 2

TAS (S.D.) to TM to CAS			
D	TAS (S.D.)		470
B	PA		25,000
C	TM	is	0.78
A	CAS	is	330

SAMPLE 3

TAS to TM to CAS			
F	TAS		485
E	TEMP		–20
C	TM	is	0.78
B	PA		25,000
A	CAS	is	330

UNCLASSIFIED

FDB–IT–(157–1)

Figure 2-62 (U) (Sheet 1 of 3)

AIRSPEED CONVERSION-CONTINUED

ICAO STANDARD DAY	
ALT. FT.	TEMP. °C
S.L.	15.0
5000	5.1
10,000	-4.8
15,000	-14.7
20,000	-24.6
25,000	-34.5
30,000	-44.4
35,000	-54.3
40,000	-56.5
45,000	-56.5
50,000	-56.5

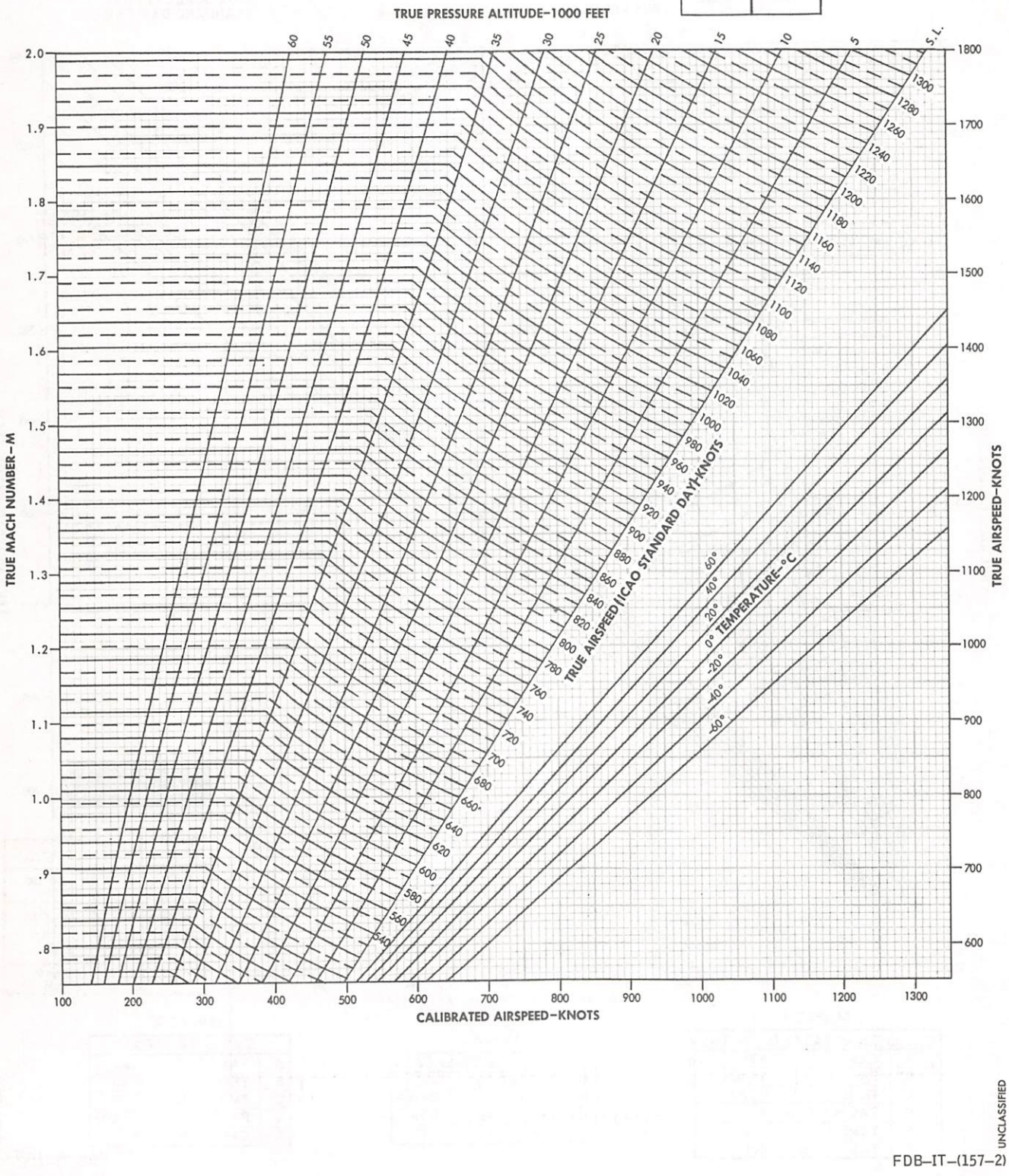
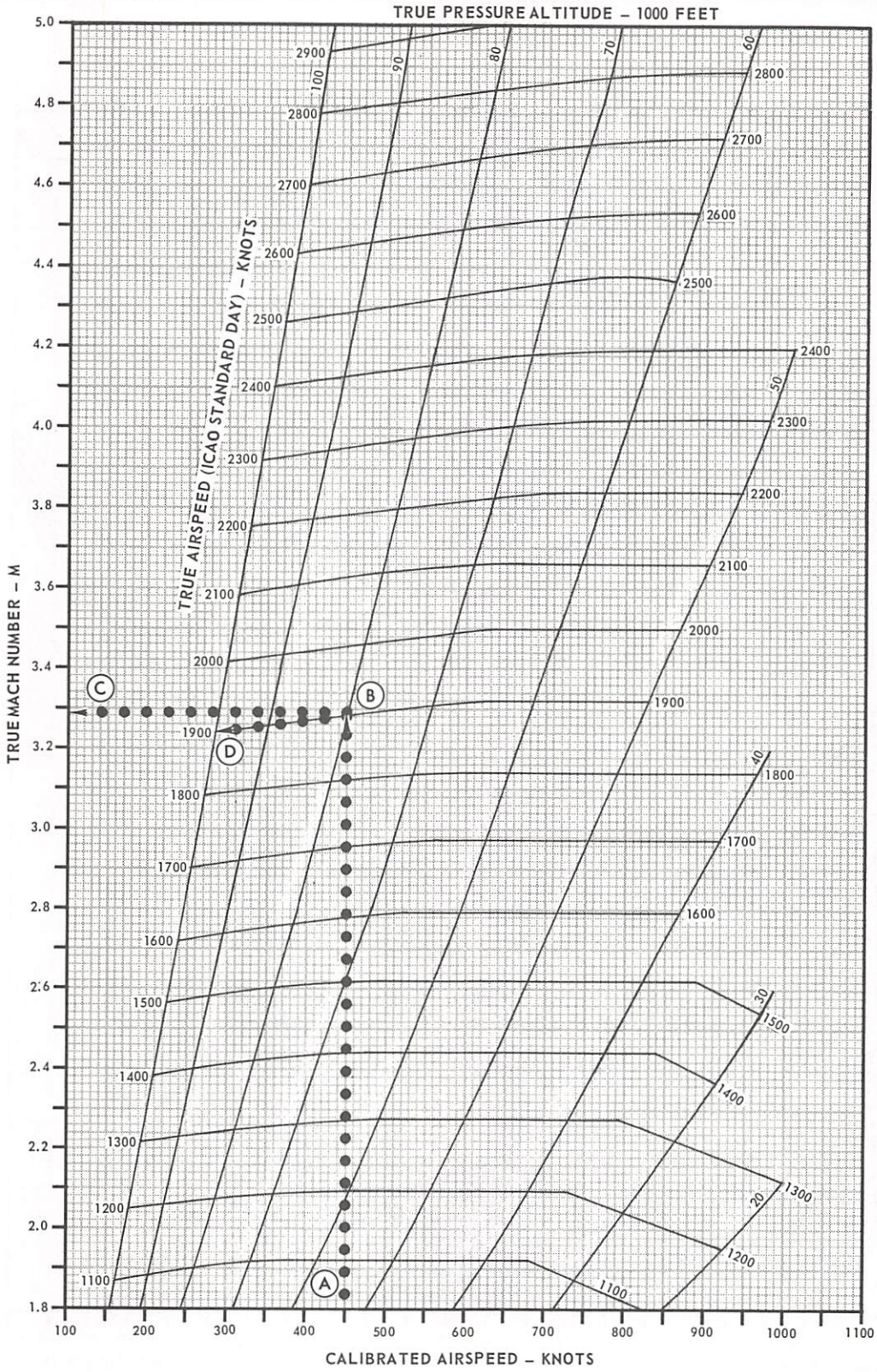


Figure 2-62 (U) (Sheet 2 of 3)

AIRSPEED CONVERSION-CONTINUED



ICAO STANDARD DAY	
ALT. FT.	TEMP. °C
S.L.	15.0
5,000	5.1
10,000	-4.8
15,000	-14.7
20,000	-24.6
25,000	-34.5
30,000	-44.4
35,000	-54.3
40,000	-56.5
45,000	-56.5
50,000	-56.5
55,000	-56.5
60,000	-56.5
65,000	-56.5
70,000	-55.2
75,000	-53.7
80,000	-52.2
85,000	-50.7
90,000	-49.2
95,000	-47.7
100,000	-46.2

SAMPLE

CAS TO TM TO TAS (S.D.)		
A	CAS	450
B	PA	80,000
C	TM IS	3.28
D	TAS (S.D.) IS 1900	

UNCLASSIFIED

FDB–1T–(157–3)

Figure 2-62 (U) (Sheet 3 of 3)

FUSELAGE ANGLE OF ATTACK

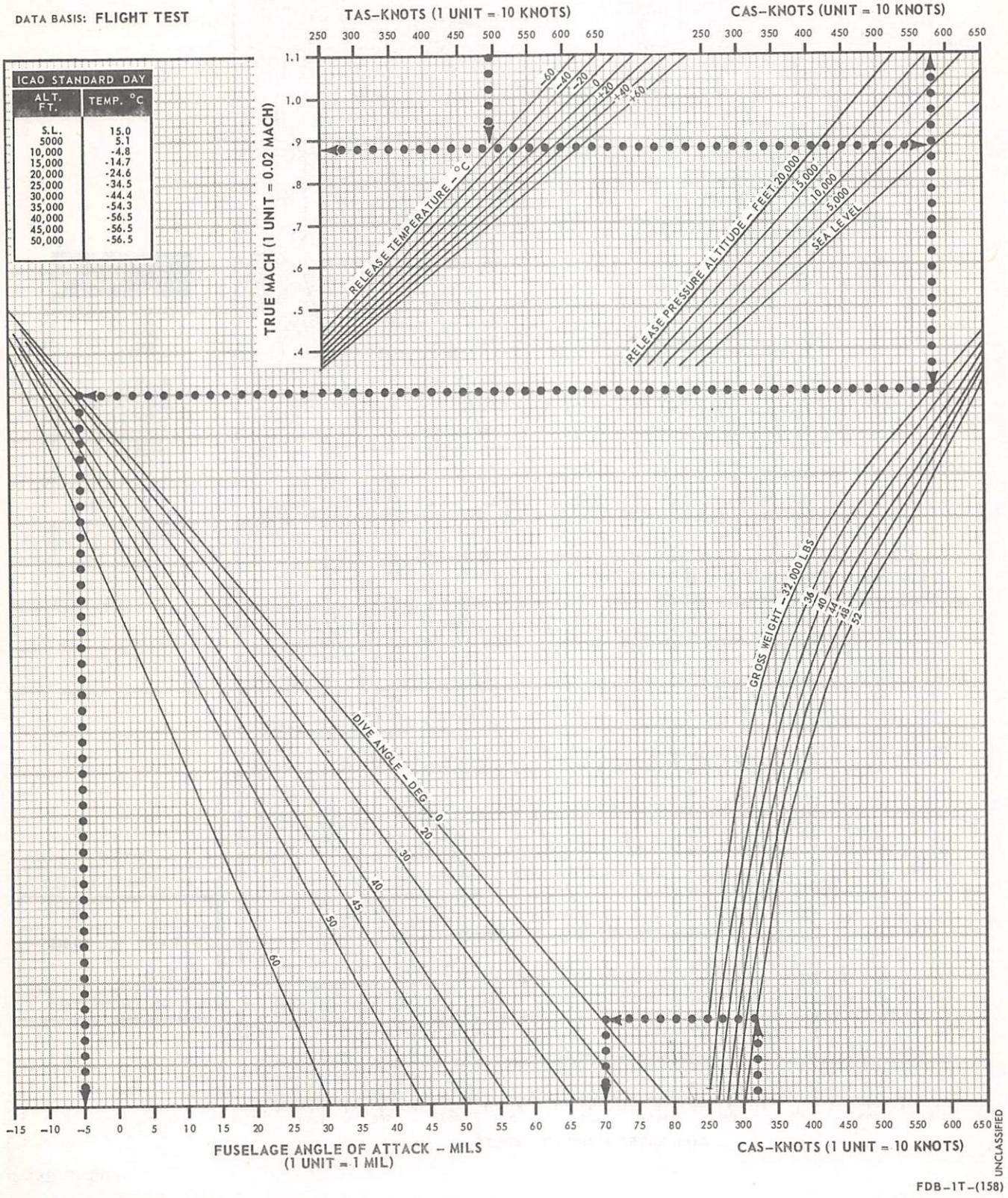


Figure 2-63 (U)

ALTIMETER LAG

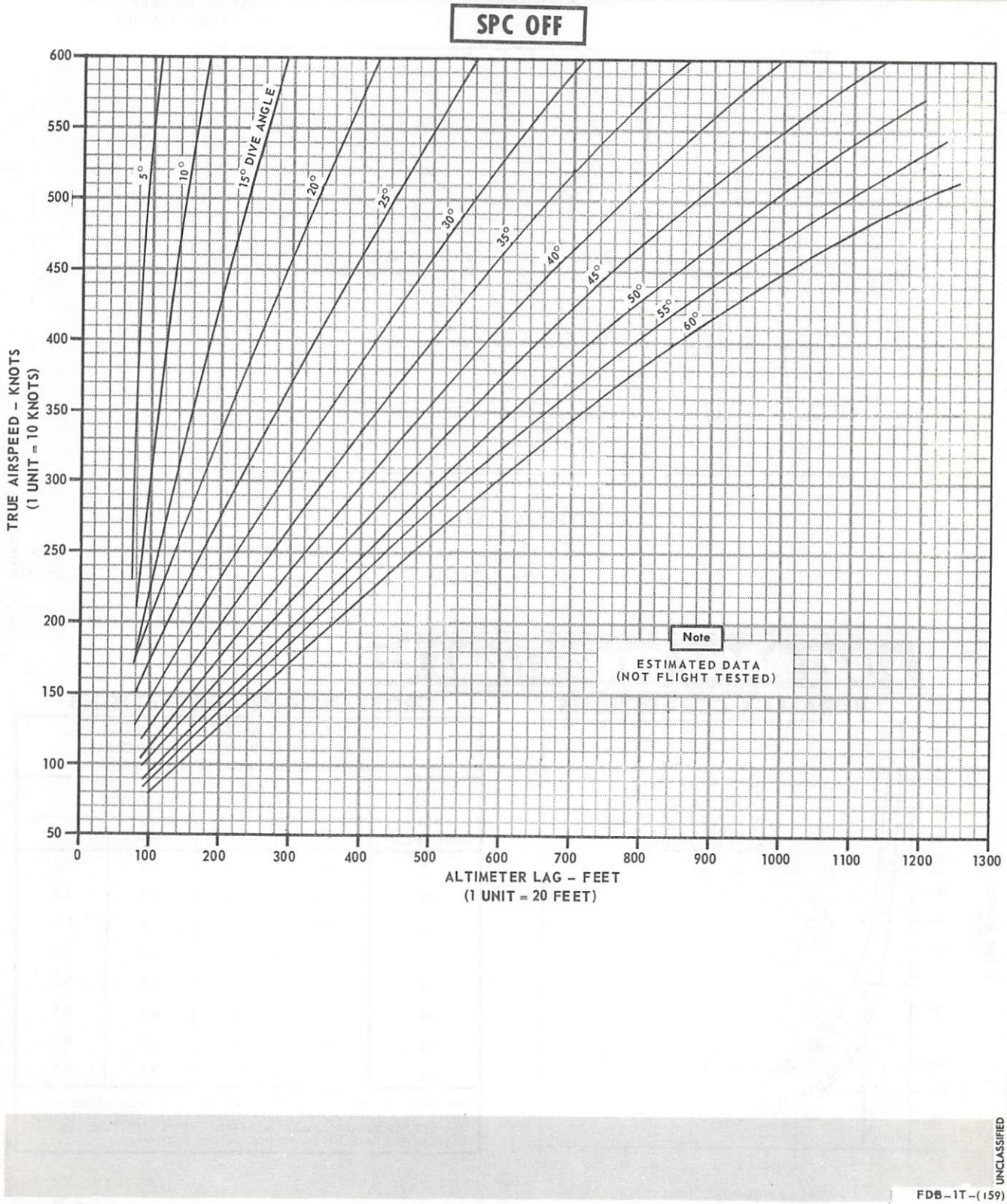


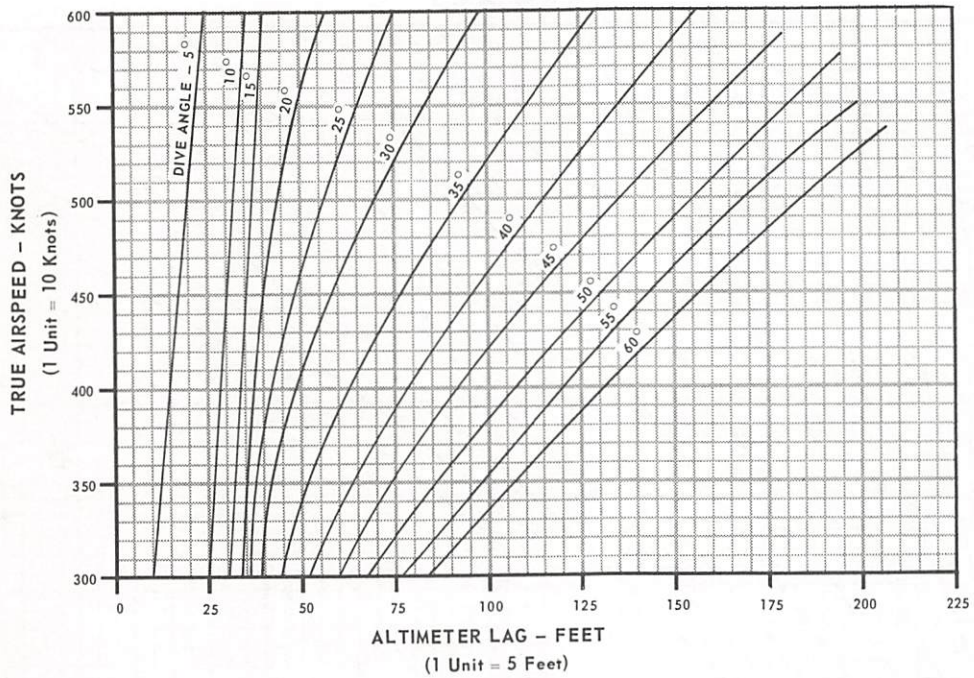
Figure 2-64 (U)

ALTIMETER LAG

SPC ON

Note

ESTIMATED DATA
(NOT FLIGHT TESTED)



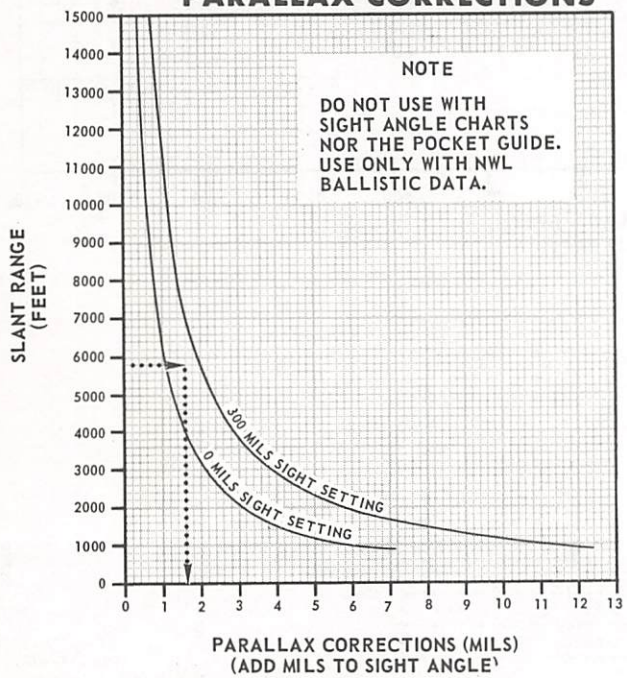
UNCLASSIFIED

FDB-1T-(160)

Figure 2-65 (U)

SIGHT ANGLE CORRECTIONS

PARALLAX CORRECTIONS



GROSS WEIGHT CORRECTIONS

CORRECTIONS TO ANGLE OF ATTACK OF FRL IN MILS FOR EACH 1000-POUND INCREASE/ DECREASE IN AIRCRAFT GROSS WEIGHT

DIVE ANGLE (DEGREES)	TRUE AIRSPEED – KNOTS			
	400	450	500	550
0	1.5	1.0	1.0	1.0
10	1.5	1.0	1.0	1.0
20	1.5	1.0	1.0	0.5
30	1.0	1.0	1.0	0.5
40	1.0	1.0	0.5	0.5
45	1.0	1.0	0.5	0.5
50	1.0	0.5	0.5	0.5
60	0.5	0.5	0.5	0.5

THIS TABLE MAY BE USED TO DETERMINE THE CORRECTION TO SIGHT ANGLE FOR A NONSTANDARD AIRCRAFT GROSS WEIGHT. THE CORRECTION IS ADDED FOR EACH 1000-POUND INCREASE IN GROSS WEIGHT AND SUBTRACTED FOR EACH 1000-POUND DECREASE IN GROSS WEIGHT.

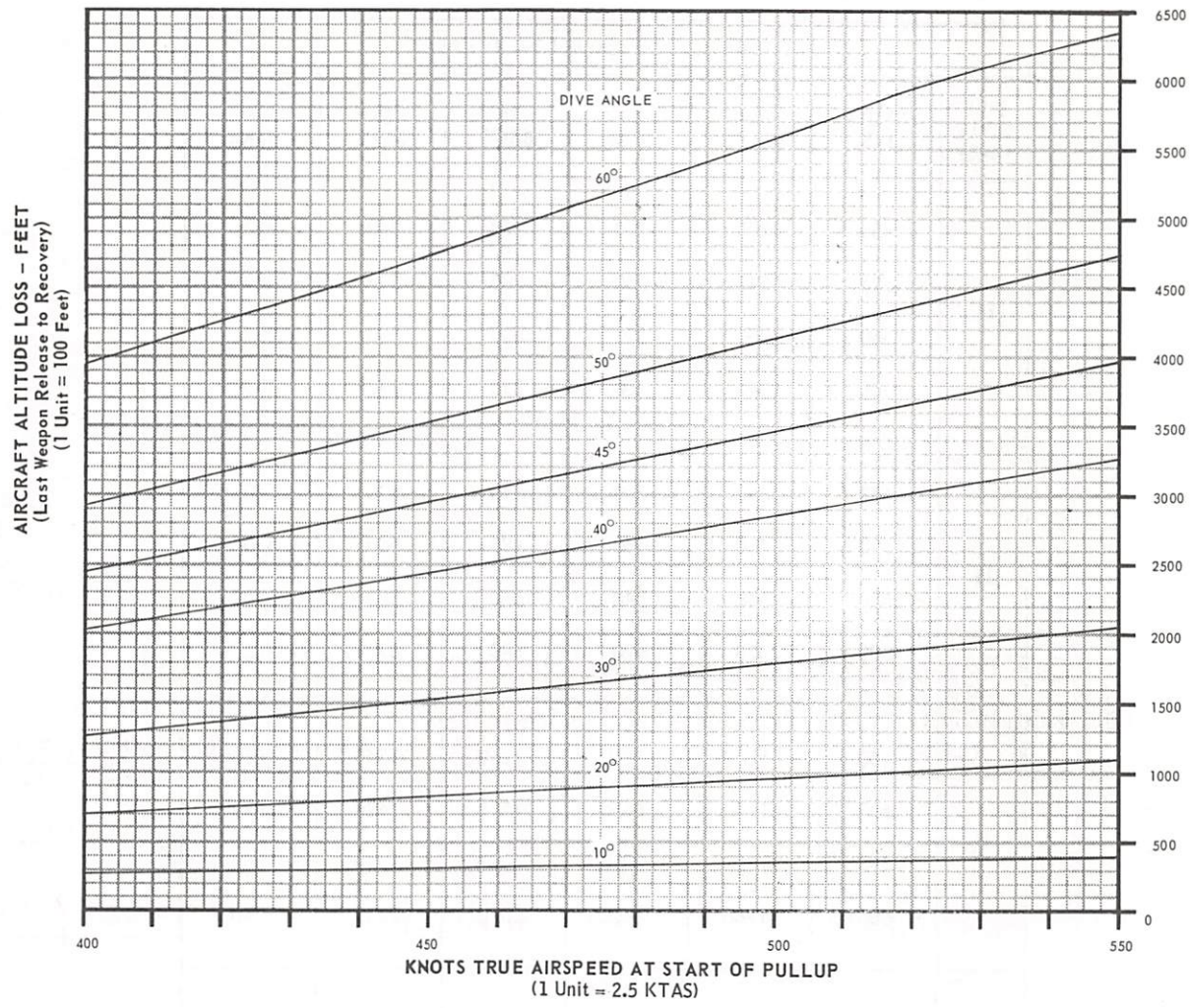
UNCLASSIFIED

FDB-1T-(161)

Figure 2-66 (U)

DIVE RECOVERY

4.0 G in 2 Sec.-Wings Level Pullup



TERRAIN AVOIDANCE (Height in Feet) AGL					
DIVE ANGLE (DEG)	400 MIN. REL.	450 MIN. REL.	500 MIN. REL.	550 MIN. REL.	ALL RECOV-ERY
0	100	100	100	100	100
10	475	525	550	600	200
20	1000	1125	1250	1400	300
30	1775	2025	2300	2550	500
40	2725	3125	3550	3975	700
45	3150	3650	4175	4675	700
50	3925	4525	5125	5725	1000
60	4950	5750	6600	7350	1000

UNCLASSIFIED

FDB-1T-(162-1)

Figure 2-67 (U) (Sheet 1 of 3)

DIVE RECOVERY

4.0-G BREAKAWAY TURN

WARNING

NO REACTION TIME INCLUDED

ALTITUDE LOST DURING RECOVERY - FEET						
DIVE ANGLE (DEG)	KNOTS TAS	WING LEVEL	10° BANK	20° BANK	30° BANK	45° BANK
10	450	200	220	230	240	250
	500	240	250	280	280	280
	550	280	300	330	330	330
	600	340	350	370	370	400
15	450	390	390	410	420	470
	500	460	460	480	500	570
	550	540	540	560	580	670
	600	620	620	640	670	780
30	450	1200	1210	1260	1340	1610
	500	1440	1450	1510	1620	1970
	550	1690	1710	1780	1920	2350
	600	1960	1990	2070	2230	2740
45	450	2390	2430	2530	2740	3420
	500	2900	2940	3080	3340	4200
	550	3430	3480	3650	3970	5000
	600	3960	4020	4210	4580	5750

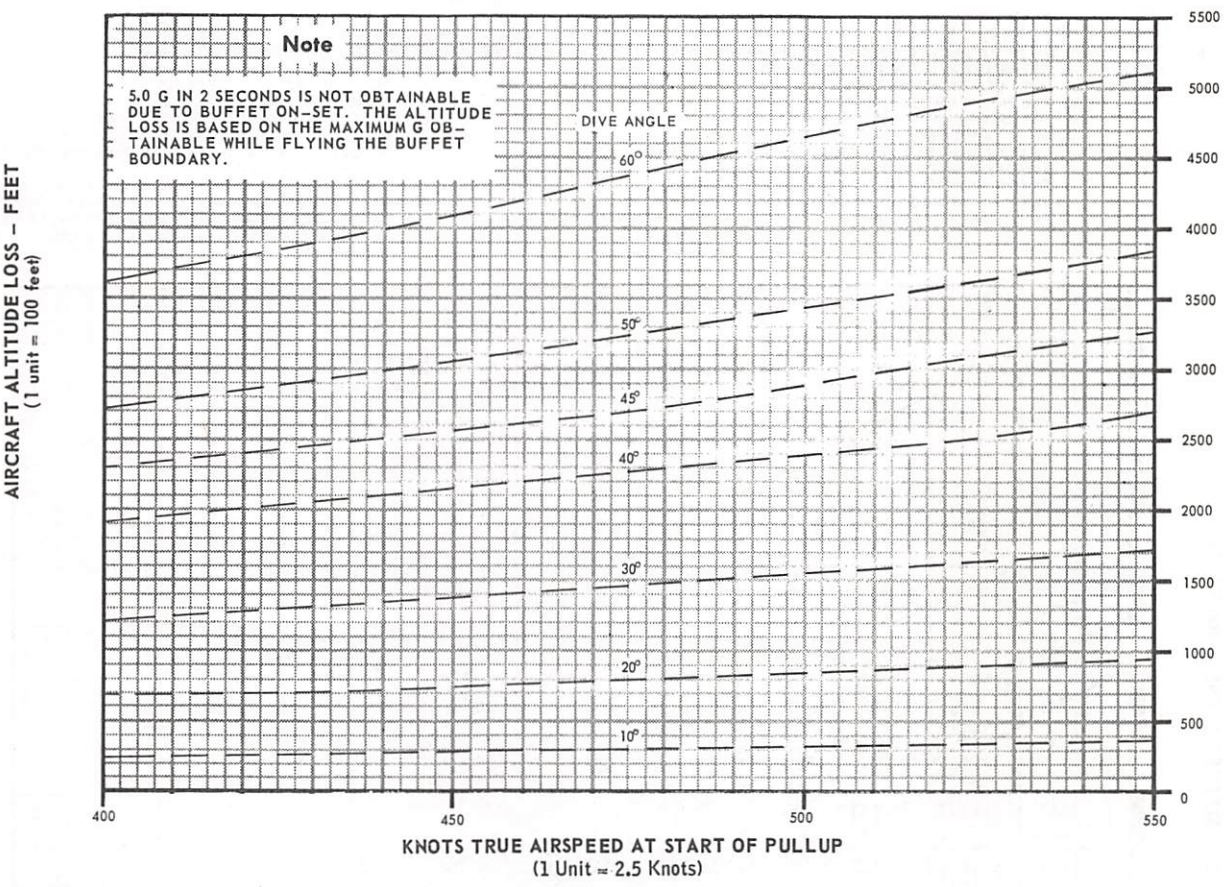
UNCLASSIFIED

FDB-1T-(162-2)

Figure 2-67 (U) (Sheet 2 of 3)

DIVE RECOVERY

5.0 G in 2 Sec - Wings Level Pullup



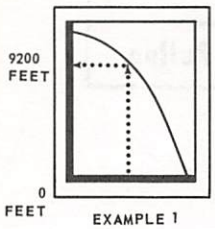
TERRAIN AVOIDANCE MIN REL ALT AGL (FT)					
5.0 G IN 2 SEC – WINGS LEVEL PULLUP					
DIVE ANGLE (DEG)	TAS at start of Pullout				RECOVERY HEIGHT
	400	450	500	550	
	MIN. REL.	MIN. REL.	MIN. REL.	MIN. REL.	
0	100	100	100	100	100
10	450	500	525	575	200
20	975	1050	1150	1250	300
30	1725	1875	2050	2225	500
40	2625	2850	3100	3400	700
45	3000	3275	3600	3975	700
50	3725	4050	4450	4850	1000
60	4625	5100	5650	6125	1000

UNCLASSIFIED
FDB-1T-(162-3)

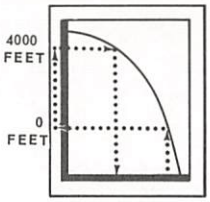
Figure 2-67 (U) (Sheet 3 of 3)

DIVE ACCELERATION

IDLE POWER



EXAMPLE 1



EXAMPLE 2

DATA BASIS: ESTIMATED
ICAO STANDARD DAY
DRAG INDEX 60
GROSS WEIGHT 42,000 POUNDS

EXAMPLE 1: FIND ENTRY HEIGHT AGL (15,200 FEET).
GIVEN:
A. POWER SETTING: IDLE POWER.
B. DIVE ANGLE: 60 DEGREES.
C. RELEASE AIRSPEED: 550 KTAS.
D. RELEASE HEIGHT: 6000 FEET AGL.
E. ENTRY AIRSPEED: 400 KTAS.

PROCEDURE:
1. ENTER CHART WITH (E), PROJECT TO (B), AND READ 9200 FEET ENTRY HEIGHT ABOVE RELEASE HEIGHT.
2. ENTRY HEIGHT EQUALS, RELEASE HEIGHT (D) PLUS ENTRY HEIGHT ABOVE RELEASE HEIGHT: (6000 FT PLUS 9200 FT = 15,200 FT).

EXAMPLE 2: FIND ENTRY AIRSPEED (359 KTAS).
GIVEN:
A. POWER SETTING: IDLE POWER.
B. DIVE ANGLE: 60 DEGREES.
C. RELEASE AIRSPEED: 450 KTAS.
D. RELEASE HEIGHT: 4000 FEET AGL.
E. ENTRY HEIGHT: 8000 FEET AGL.
F. HEIGHT ABOVE RELEASE HEIGHT: (8000 FT MINUS 4000 FT = 4000 FT).

PROCEDURE:
1. ENTER WITH (C) PROJECT TO (B) PROJECT LEFT TO ESTABLISH ZERO HEIGHT REFERENCE. PROJECT VERTICALLY 4000 FEET (F) TO THE ENTRY HEIGHT ABOVE RELEASE. PROJECT TO (B), PROJECT DOWN AND READ ENTRY AIRSPEED 359 KTAS.

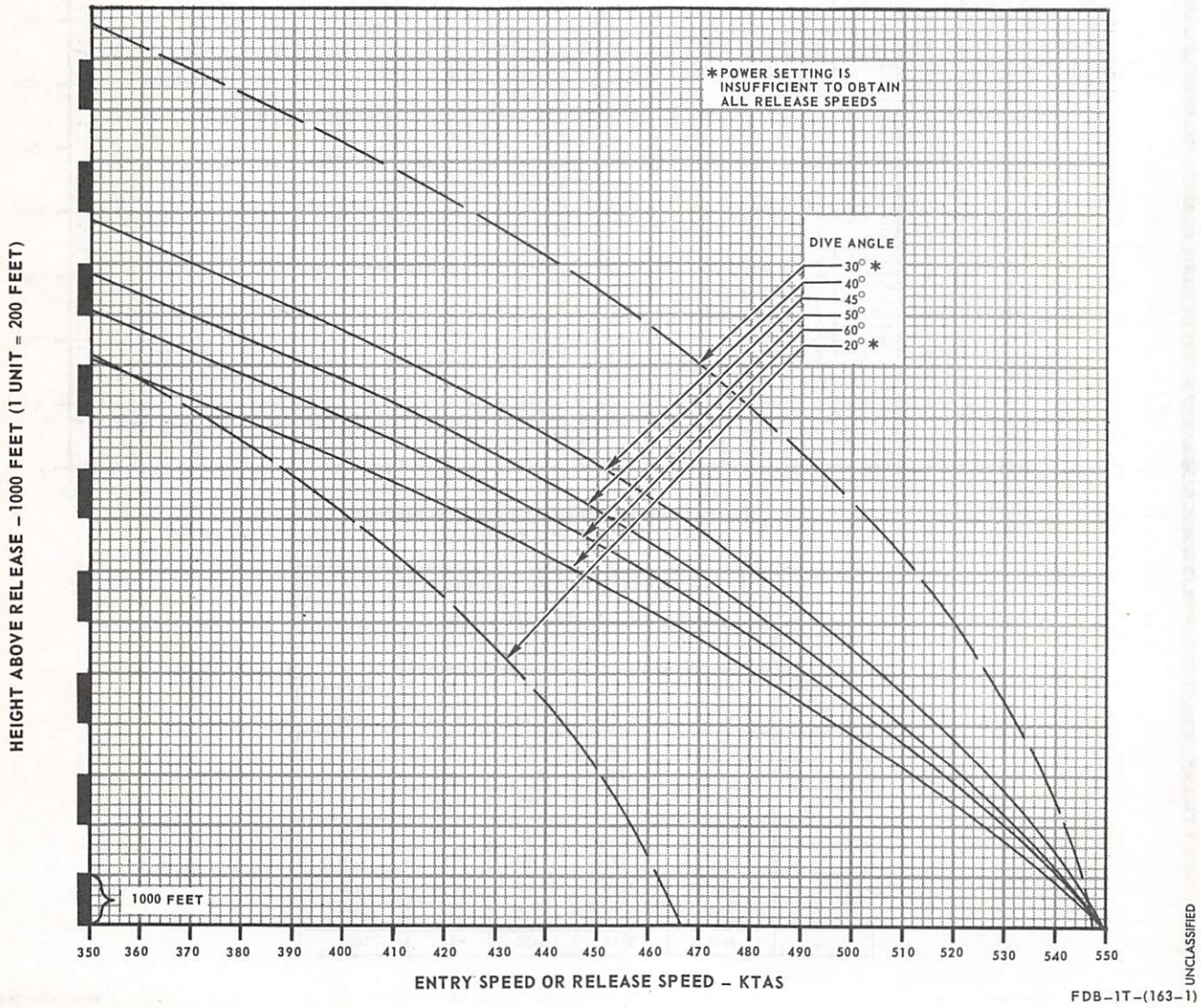
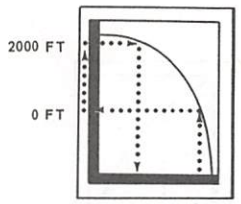


Figure 2-68 (U) (Sheet 1 of 3)

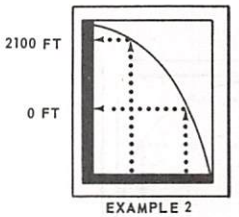
DIVE ACCELERATION

88% POWER



EXAMPLE 1

DATA BASIS: ESTIMATED
ICAO STANDARD DAY
DRAG INDEX 60
GROSS WEIGHT; 42,000 POUNDS



EXAMPLE 2

EXAMPLE 1: FIND ENTRY AIRSPEED (403 KTAS)
GIVEN:
A. POWER SETTING: 88% POWER
B. DIVE ANGLE: 20 DEGREES.
C. RELEASE AIRSPEED: 450 KTAS.
D. RELEASE HEIGHT: 1000 FEET AGL.
E. ENTRY HEIGHT: 3000 FEET AGL.
F. HEIGHT ABOVE RELEASE HEIGHT; (E) MINUS (D); 3000 FT. MINUS 1000 FT = 2000 FT.)

PROCEDURE: 1 ENTER CHART WITH (C), PROJECT TO (B), PROJECT LEFT TO ESTABLISH ZERO HEIGHT REFERENCE. PROJECT VERTICALLY 2000 FEET (F) TO THE ENTRY HEIGHT ABOVE REFERENCE. PROJECT DOWN AND READ ENTRY AIRSPEED, 403 KTAS.

EXAMPLE 2: FIND ENTRY HEIGHT (3100 FEET).
GIVEN:
A. POWER SETTING: 88% POWER.
B. DIVE ANGLE: 20 DEGREES.
C. RELEASE AIRSPEED: 450 KTAS.
D. RELEASE HEIGHT: 1000 FEET.
E. ENTRY AIRSPEED: 400 KTAS.

PROCEDURE:
1. ENTER CHART WITH (C), PROJECT TO (B), PROJECT LEFT TO ESTABLISH ZERO HEIGHT REFERENCE.
2. ENTER CHART WITH (E), PROJECT TO (B), PROJECT LEFT TO ESTABLISH THE ENTRY HEIGHT REFERENCE.
3. THE ENTRY HEIGHT ABOVE RELEASE HEIGHT IS THE DIFERENCE BETWEEN THE ZERO HEIGHT REFERENCE AND THE ENTRY HEIGHT REFERENCE (2100 FEET).
4. ENTRY HEIGHT IS THE SUM OF RELEASE HEIGHT (D) AND THE HEIGHT ABOVE RELEASE (3). (1000 FT. PLUS 2100 FT. = 3100 FT AGL.).

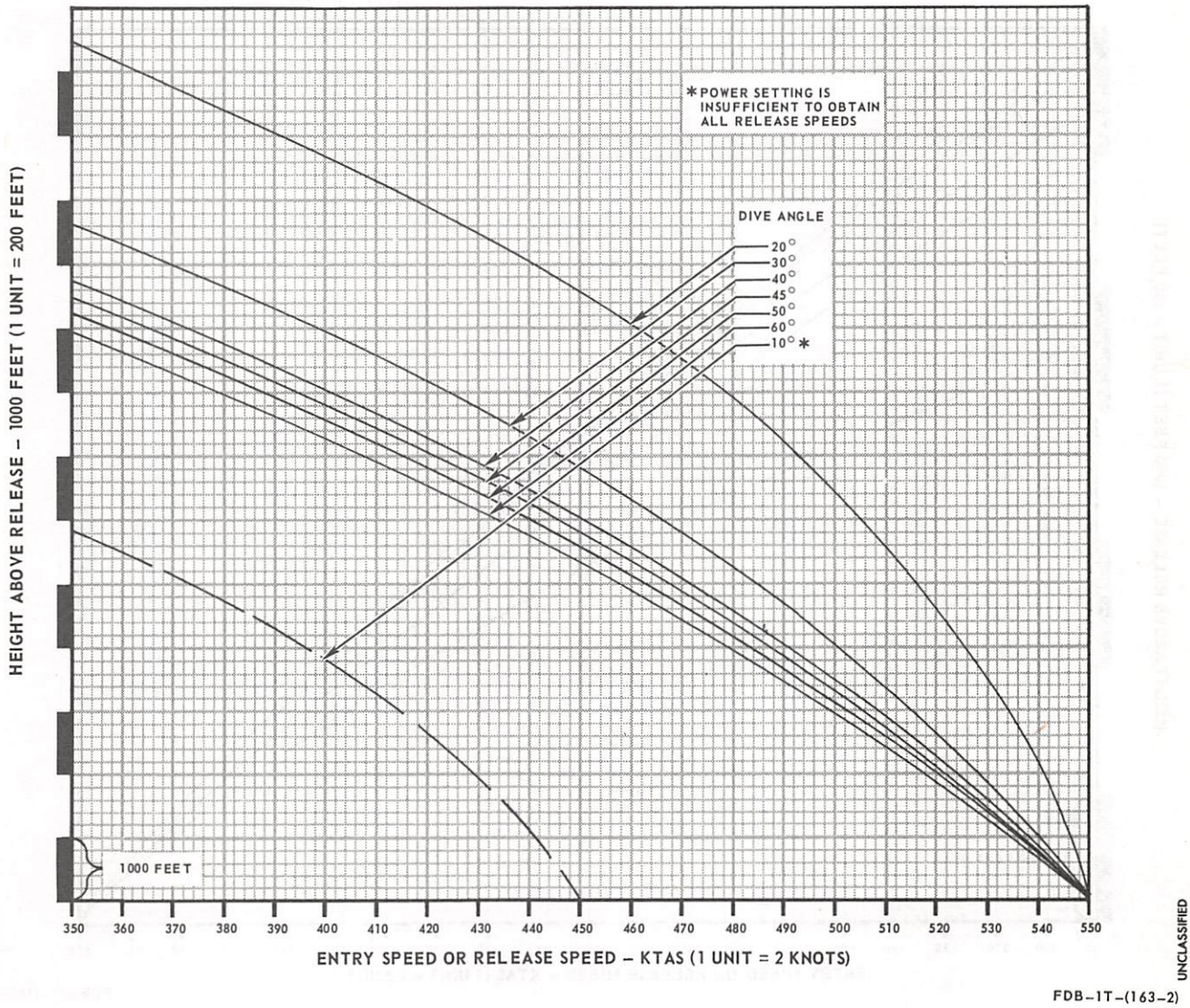
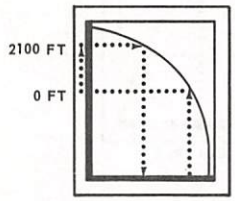


Figure 2-68 (U) (Sheet 2 of 3)

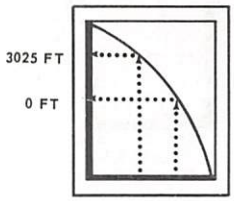
DIVE ACCELERATION

MILITARY POWER



EXAMPLE 1

DATA BASIS: ESTIMATED
ICAO STANDARD DAY
DRAG INDEX 60
GROSS WEIGHT 42,000 POUNDS



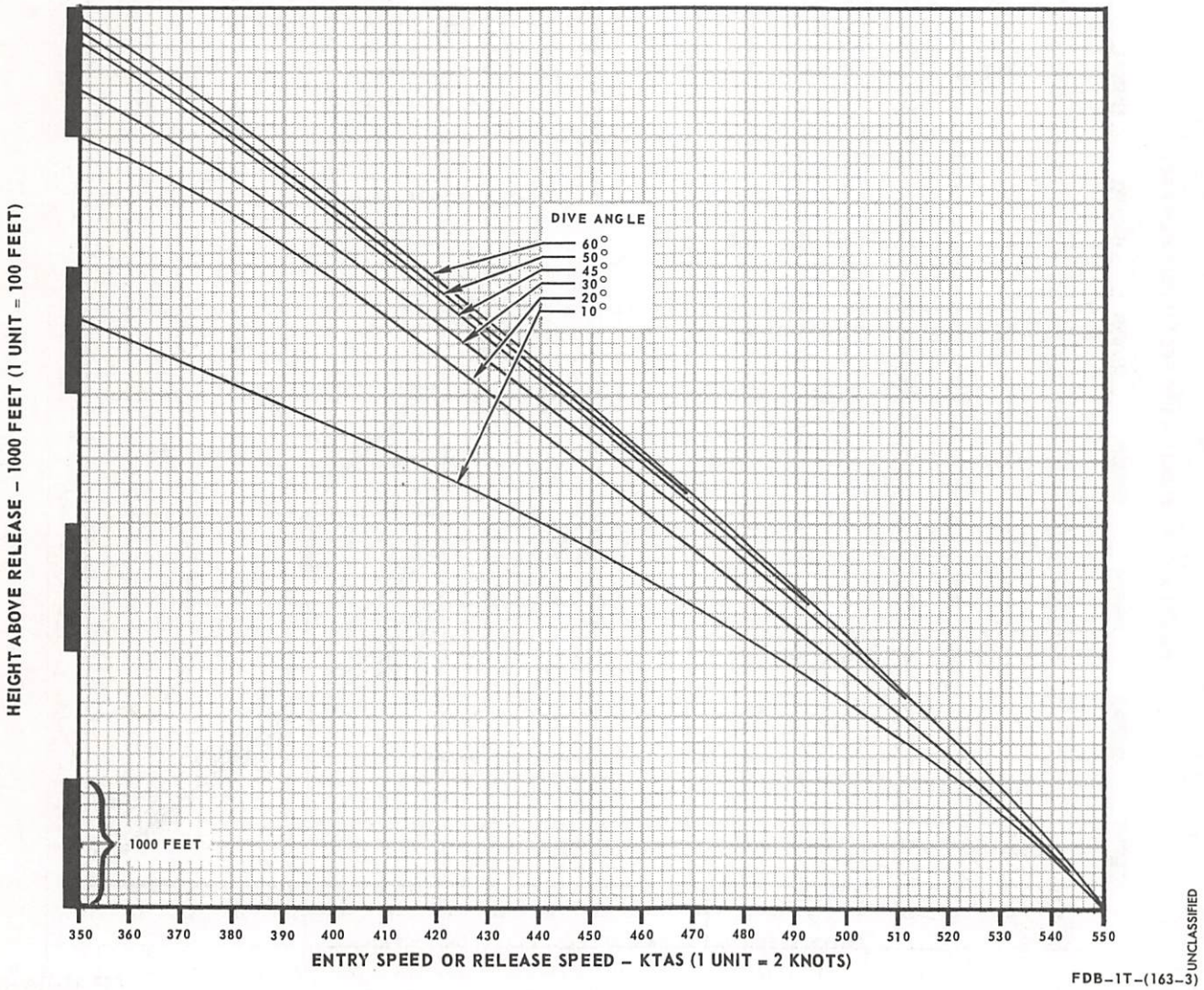
EXAMPLE 2

EXAMPLE 1: FIND ENTRY AIRSPEED (376 KTAS).
GIVEN:
A. POWER SETTING: MILITARY POWER.
B. DIVE ANGLE: 20 DEGREES.
C. RELEASE AIRSPEED: 450 KTAS.
D. RELEASE HEIGHT: 900 FEET AGL.
E. ENTRY HEIGHT: 3000 FEET AGL.
F. HEIGHT ABOVE RELEASE HEIGHT: (3000 FT MINUS 900 FT = 2100 FT).

PROCEDURE:
1. ENTER WITH (C), PROJECT TO (B), PROJECT LEFT TO ESTABLISH ZERO HEIGHT REFERENCE. PROJECT VERTICALLY 2100 FEET (F) TO THE ENTRY HEIGHT ABOVE RELEASE. PROJECT TO (B), PROJECT DOWN AND READ ENTRY AIRSPEED, 376 KTAS.

EXAMPLE 2: FIND ENTRY HEIGHT (3925 FT AGL).
GIVEN:
A. POWER SETTING: MILITARY POWER
B. DIVE ANGLE: 20 DEGREES.
C. RELEASE AIRSPEED: 500 KTAS.
D. RELEASE HEIGHT: 900 FEET AGL.
E. ENTRY AIRSPEED: 400 KTAS.

PROCEDURE:
1. ENTER CHART WITH (C), PROJECT TO (B), PROJECT LEFT TO ESTABLISH ZERO HEIGHT REFERENCE.
2. ENTER CHART WITH (E), PROJECT TO (B), PROJECT LEFT TO ESTABLISH ENTRY HEIGHT REFERENCE.
3. THE ENTRY HEIGHT ABOVE RELEASE HEIGHT IS THE DIFFERENCE BETWEEN THE ZERO HEIGHT REFERENCE AND ENTRY HEIGHT REFERENCE (3025 FEET).
4. ENTRY HEIGHT IS THE SUM OF RELEASE HEIGHT (D) AND THE HEIGHT ABOVE RELEASE (3). (900 FT PLUS 3025 FT = 3925 FEET AGL.



FDB-1T-(163-3)

Figure 2-68 (U) (Sheet 3 of 3)

DIVE ANGLE / HORIZONTAL DISTANCE

POP–UP DISTANCE

To find the horizontal distance from target where the pop–up maneuver is initiated, enter the chart with the desired entry height AGL (12,000 feet) and dive angle (40°), project down and read 14,200 feet. Multiplying 14,200 feet by 2.5 equals 35,000 feet.

INDICATED SLANT RANGE (F–4J)

Project +2° horizontally (along the Height AGL) from the dive angle and read the indicated slant range displayed on the radar scope when the antenna is 2° below FRL.

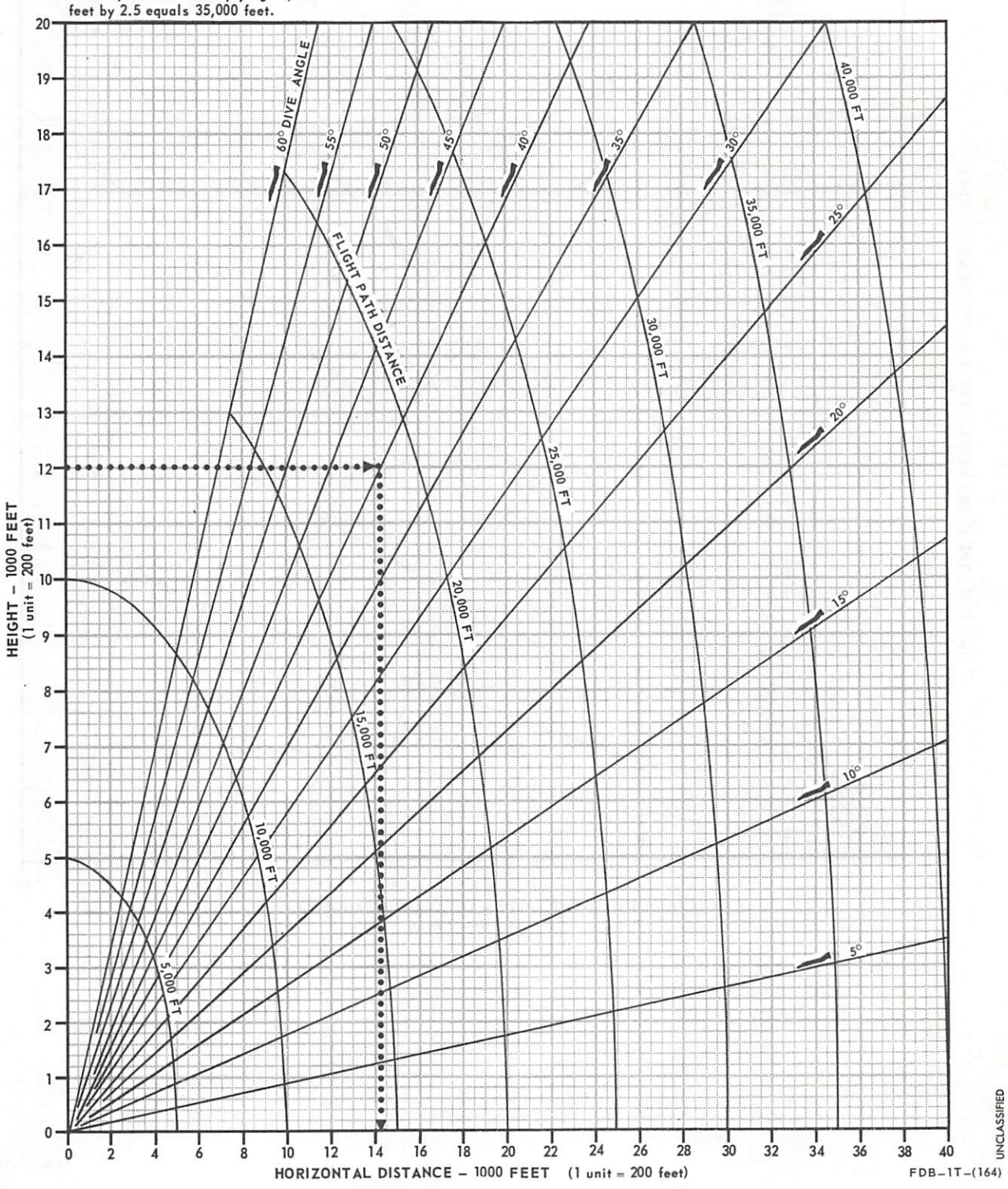
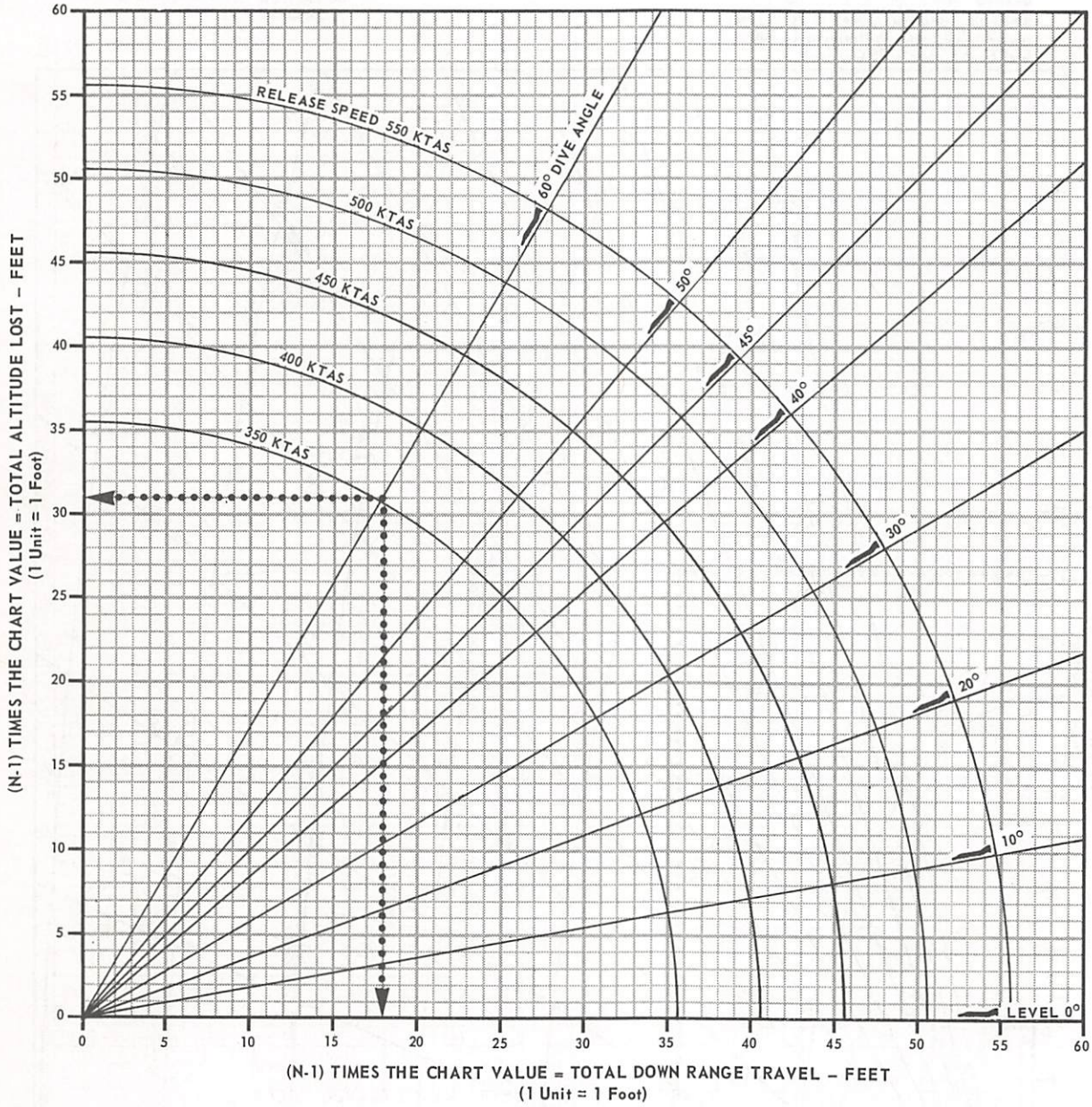


Figure 2-69 (U)

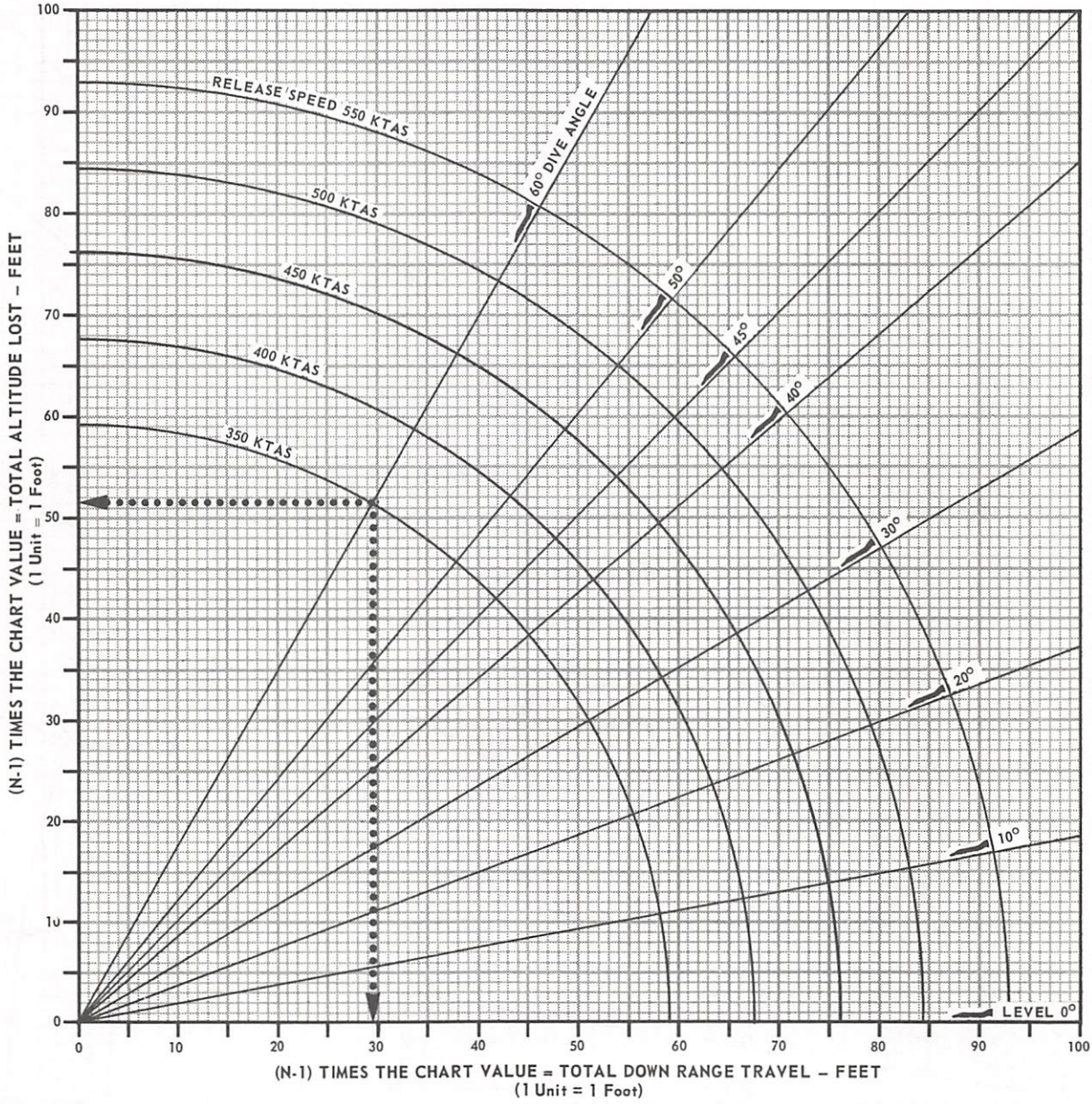
AIRCRAFT DOWN RANGE TRAVEL AND ALTITUDE LOSS FOR A RELEASE INTERVAL OF 0.06 SECONDS



UNCLASSIFIED
FDB-1T-(165-1)

Figure 2-70 (U) (Sheet 1 of 3)

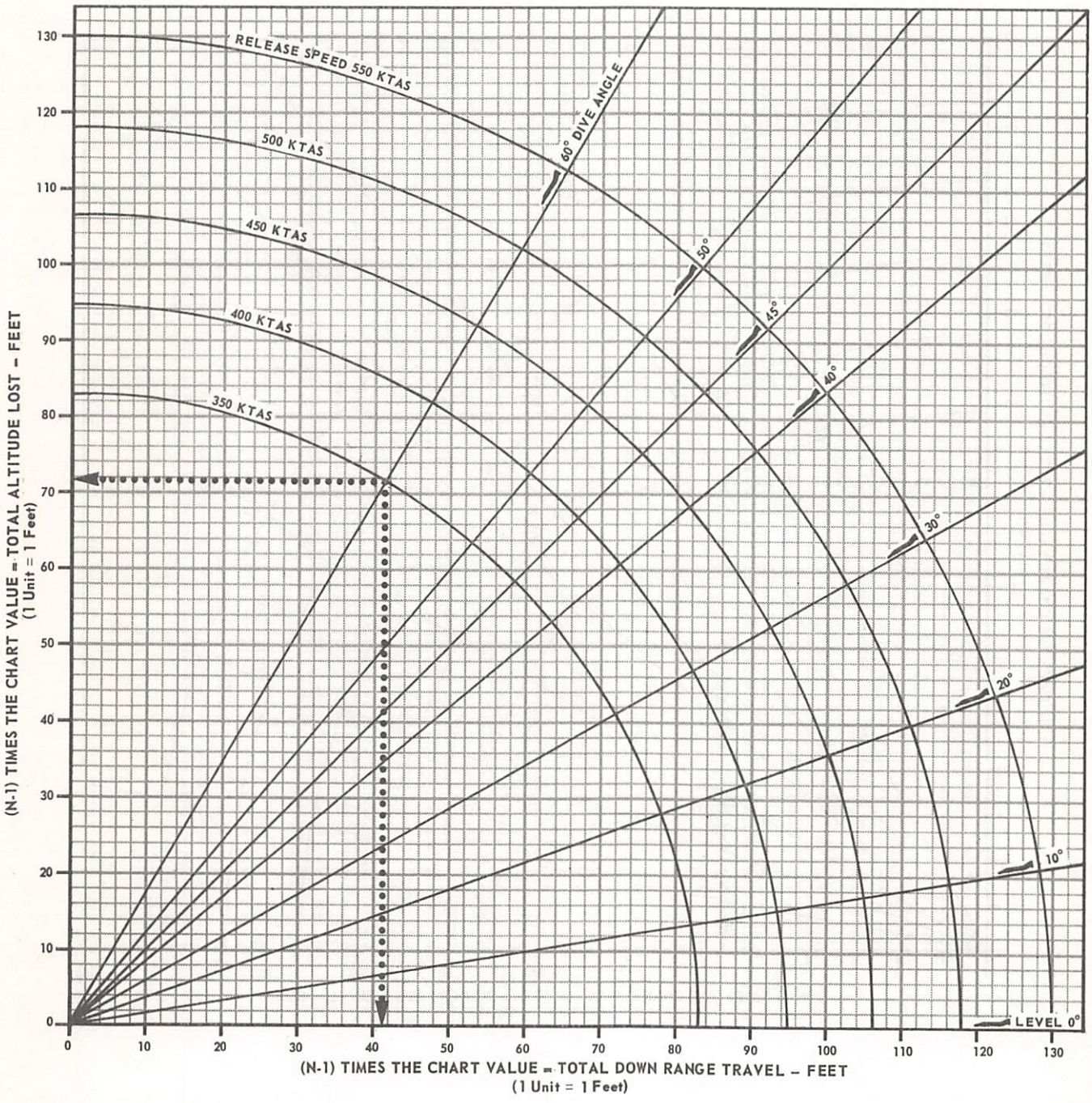
AIRCRAFT DOWN RANGE TRAVEL AND ALTITUDE LOSS FOR A RELEASE INTERVAL OF 0.10 SECONDS



UNCLASSIFIED
FDB-1T-(165-2)

Figure 2-70 (U) (Sheet 2 of 3)

AIRCRAFT DOWN RANGE TRAVEL AND ALTITUDE LOSS FOR A RELEASE INTERVAL OF 0.140 SECONDS

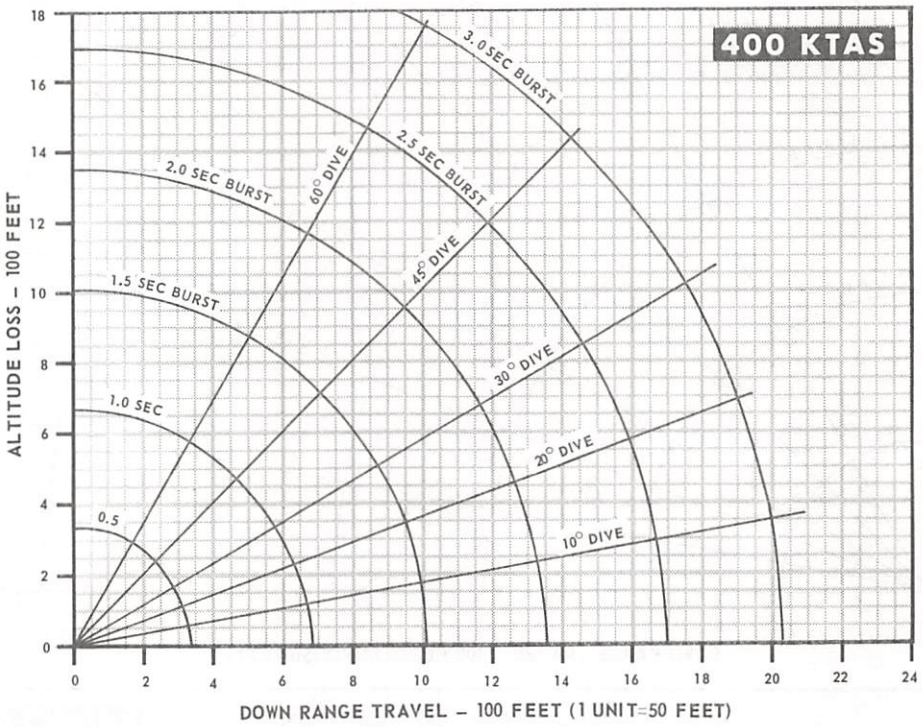


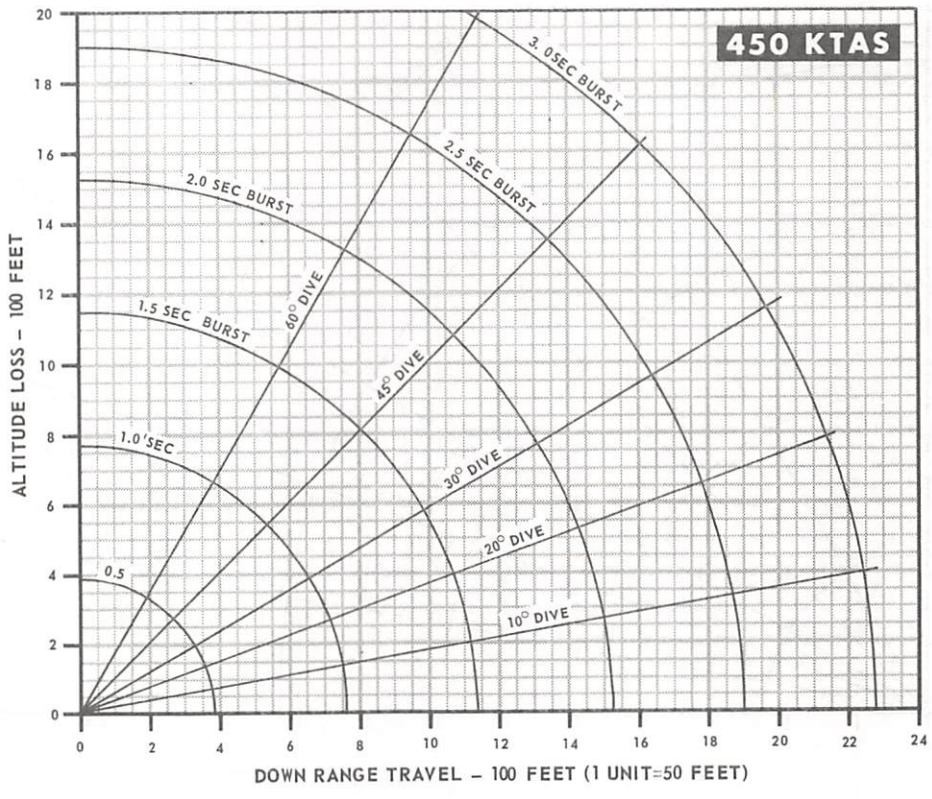
UNCLASSIFIED

FDB-1T-(165-3)

Figure 2-70 (U) (Sheet 3 of 3)

STRAFING DOWN RANGE TRAVEL AND ALTITUDE LOSS



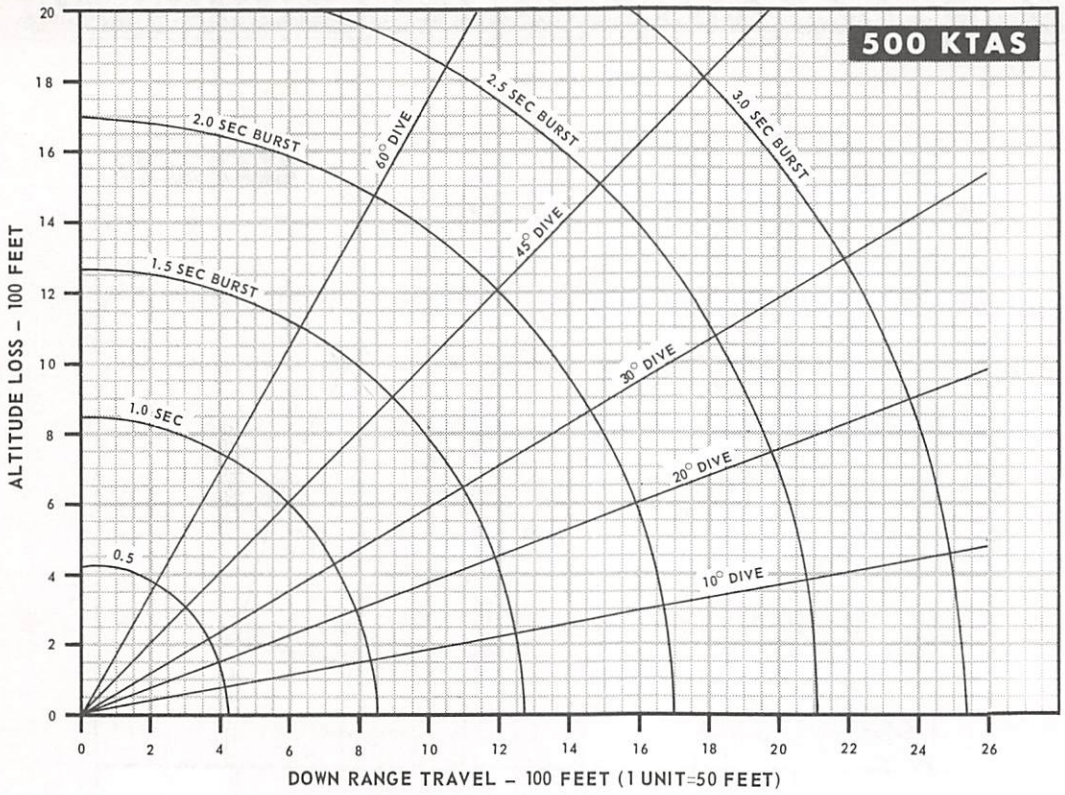


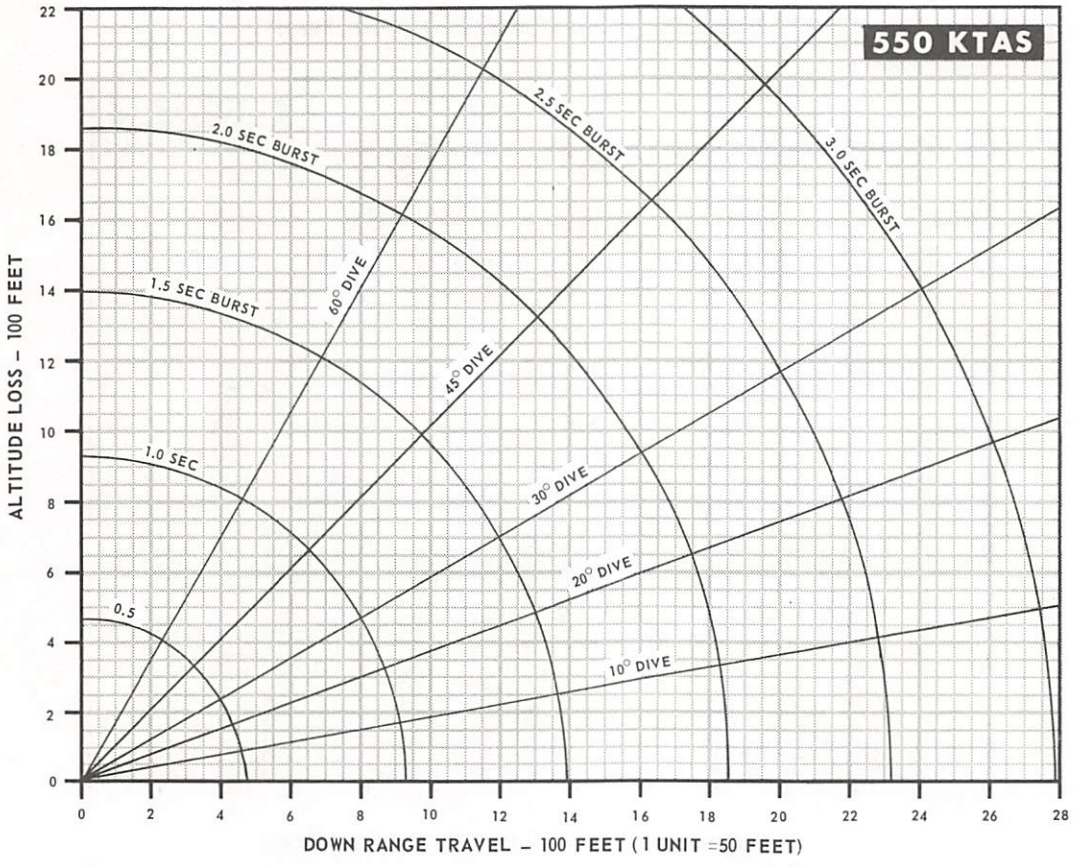
UNCLASSIFIED

FDB-1T-(166-1)

Figure 2-71 (U) (Sheet 1 of 2)

STRAFING DOWN RANGE TRAVEL AND ALTITUDE LOSS-CONTINUED



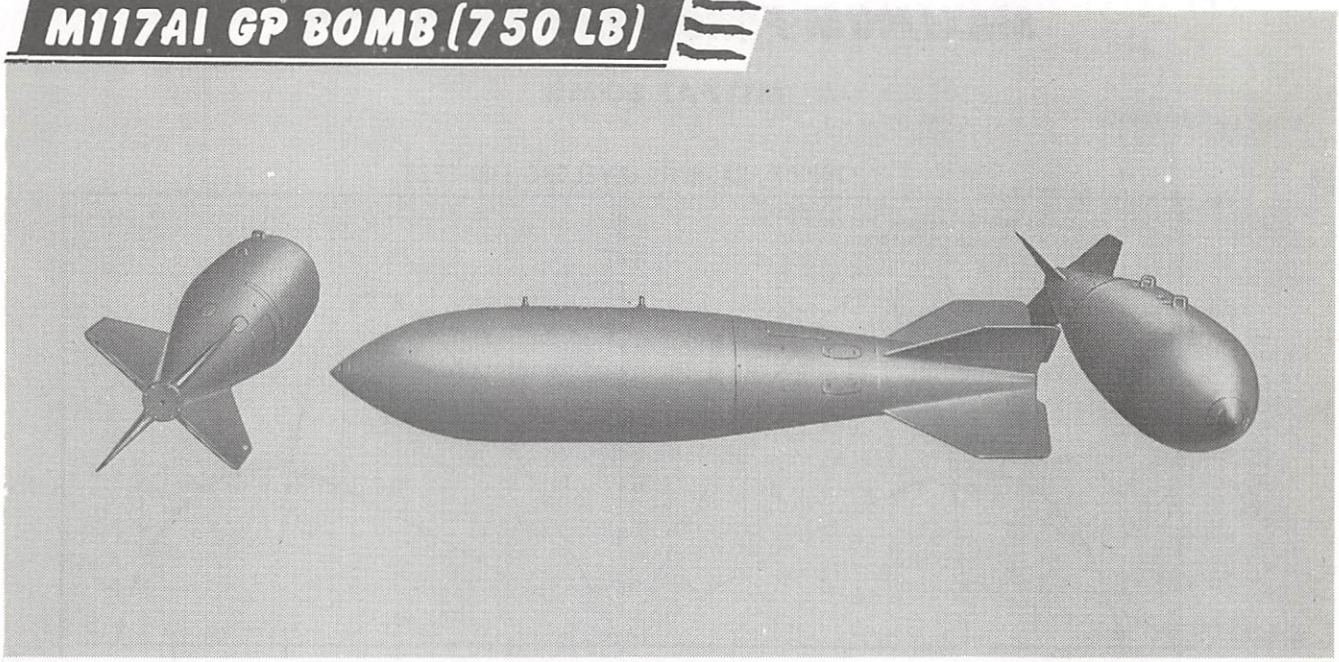


UNCLASSIFIED

FDB-1T-(166-2)

Figure 2-71 (U) (Sheet 2 of 2)

M117A1 GP BOMB (750 LB)



CHARACTERISTICS:	
LENGTH	7 FEET, 6 INCHES
DIAMETER	16.0 INCHES
EXPLOSIVE CHARGE	APPROX. 400 POUNDS.
WEIGHT (LOADED)	823 POUNDS
SUSPENSION	14 INCHES
TOP OF FRAG PATTERN	3790 FEET

DESCRIPTION

The M117 A1 bomb is a general purpose bomb used for blast, mining, or fragmentation. The basic structural material of the bomb is steel. Approximately 50% of its weight is H-6 explosive. The bomb is adapted for use of nose and/or tail fuze. The M131 (T152E2) or M131A1 conical fin assembly is used to stabilize the bomb in flight.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-2.1

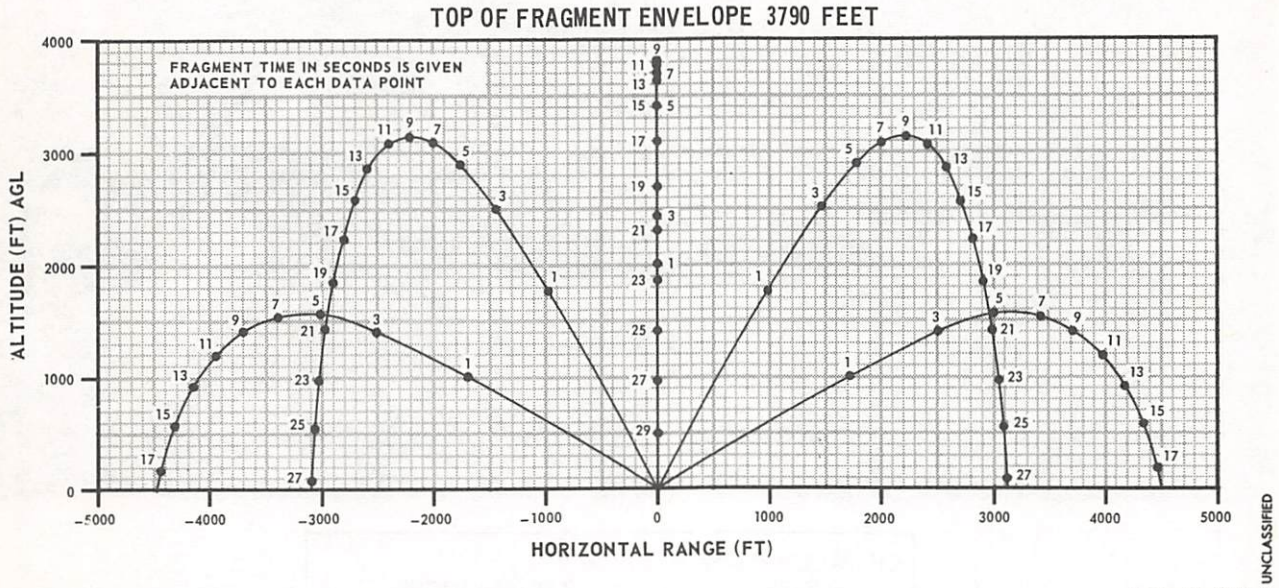
UNCLASSIFIED

FDB-1T-(167-1)

Figure 2-72 (U) (Sheet 1 of 7)

MAXIMUM FRAGMENT ENVELOPE

M117A1 BOMB



FDB-1T-(167-2) UNCLASSIFIED

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

M117A1 GP BOMB (M131 FIN)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	2000	450	177	-178	-210	200	290	-371	34.6	-36.1	8.4	187	5.3	188	22.4
20°	2500	450	48	- 50	- 50	40	46	- 54	11.4	-11.6	5.4	115	10.0	116	21.4
30°	3000	450	31	- 33	- 20	20	26	- 30	8.4	- 8.5	5.0	106	12.6	106	21.2
	5000	500	52	-53	-30	30	49	- 55	13.0	-13.2	8.1	152	11.6	152	18.8
45°	4000	450	21	- 22	-10	10	17	- 19	6.7	- 6.8	5.2	107	15.9	107	20.6
	6000	500	30	-31	-10	10	29	- 31	9.9	-9.9	7.7	142	14.3	142	18.4
60°	7000	500	18	-19	-10	10	22	- 23	8.6	- 8.6	7.8	140	16.3	141	18.1

FDB-1T-(167-3) UNCLASSIFIED

Figure 2-72 (U) (Sheet 2 of 7)

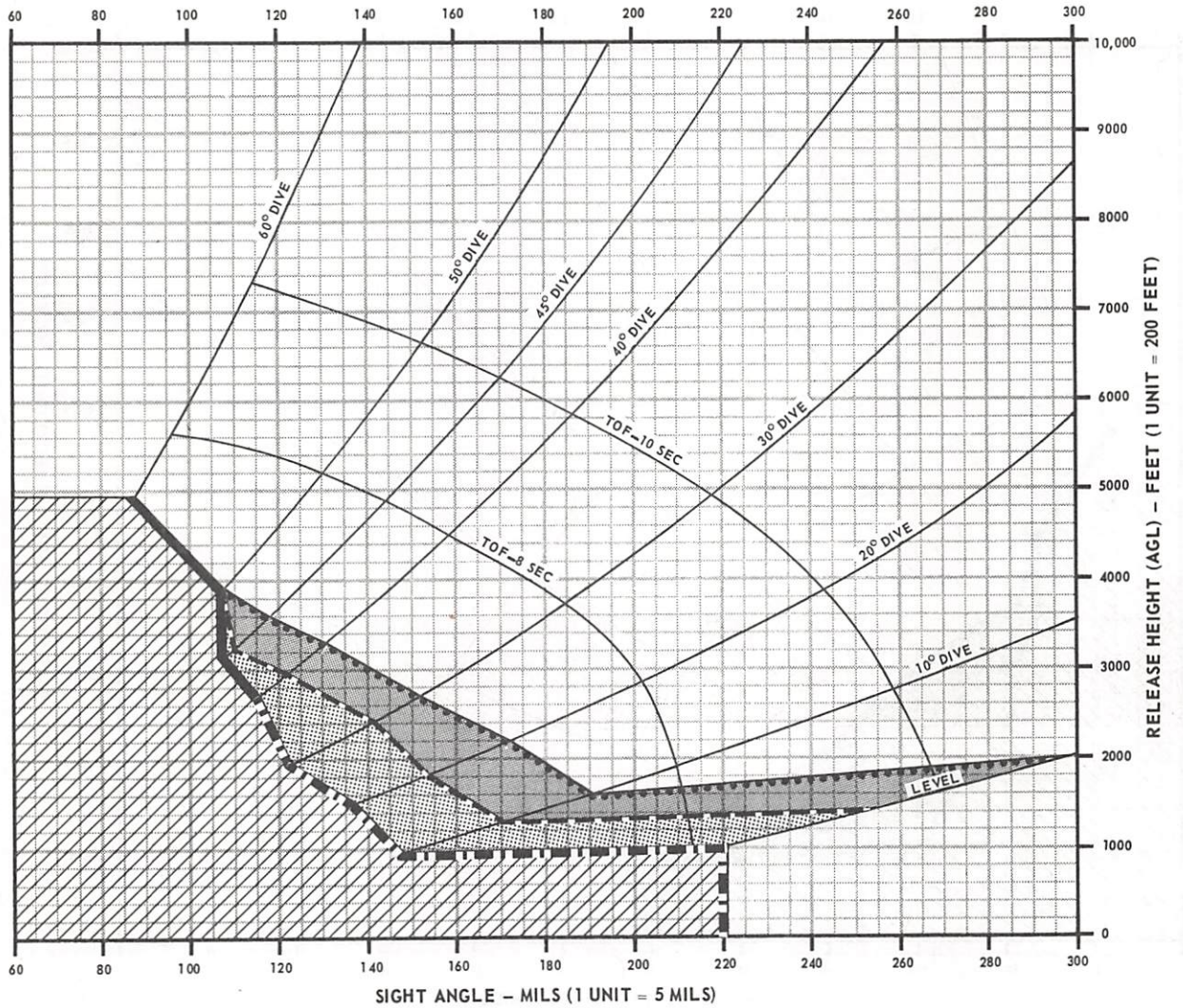
SIGHT ANGLE

M117A1 GP BOMB (M131 FIN)

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	2000	297	2000	1450	258	1450	1025	221	1025
10	1600	193	1325	1300	173	1025	975	147	700
20	2200	173	1500	1850	156	1150	1500	137	800
30	2700	149	1425	2425	140	1150	1975	123	700
40	3300	129	1275	2975	122	950	2725	115	700
45	3600	118	1150	3225	110	775	3150	110	700
50	3925	107	1000	3925	107	1000	3925	107	1000
60	4950	88	1000	4950	88	1000	4950	88	1000

FRAG
TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

M117A1 GP: 823 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(167-4)

Figure 2-72 (U) (Sheet 3 of 7)

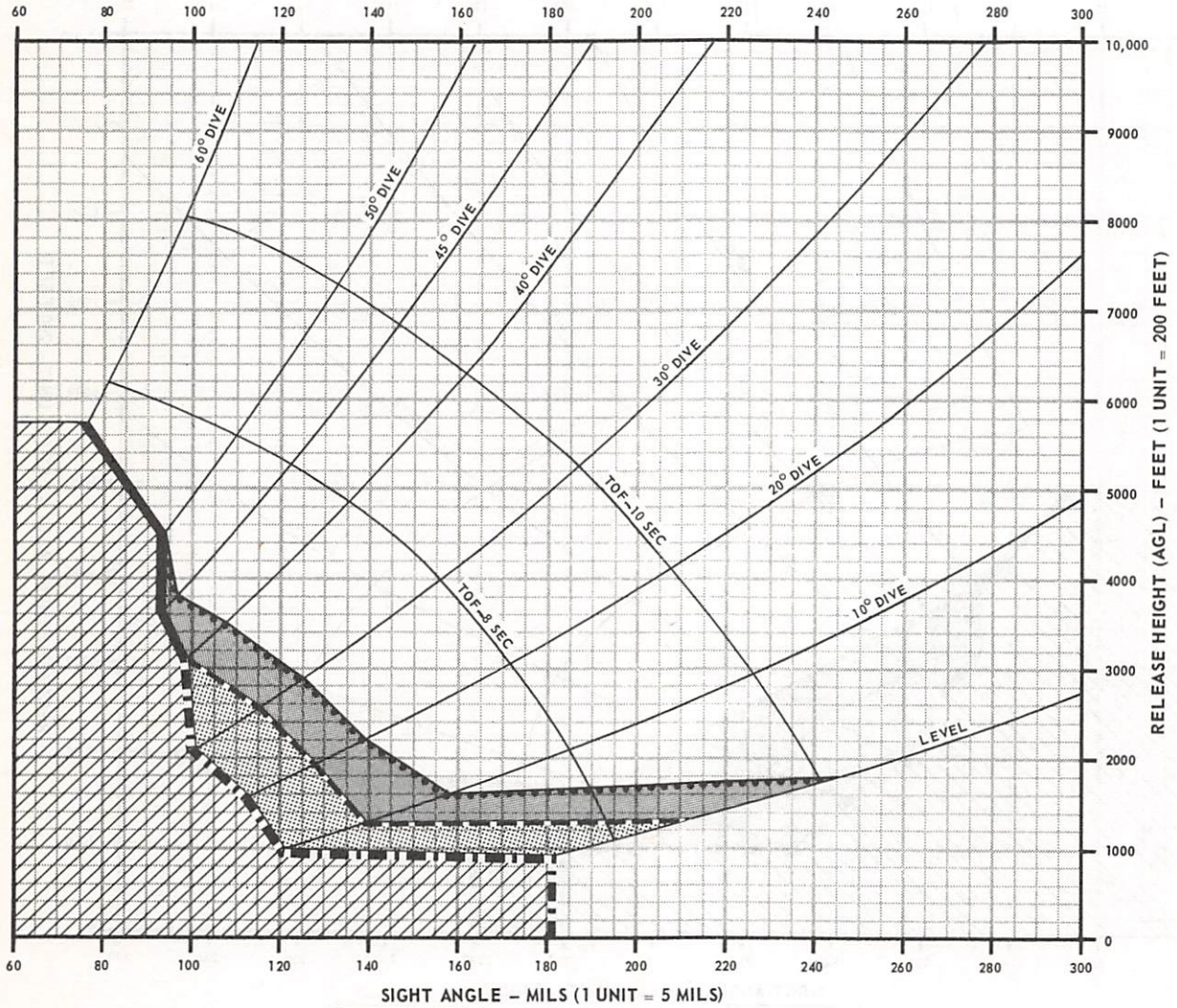
SIGHT ANGLE

M117A1 GP BOMB (M131 FIN)

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1800	246	1800	1325	214	1325	925	182	925
10	1600	158	1275	1300	140	975	1000	121	675
20	2200	139	1375	1950	128	1125	1575	113	750
30	2900	124	1375	2575	115	1050	2100	101	575
40	3500	107	1075	3125	99	700	3125	99	700
45	3800	97	850	3650	94	700	3650	94	700
50	4525	94	1000	4525	94	1000	4525	94	1000
60	5750	77	1000	5750	77	1000	5750	77	1000

NEW NEW NEW FRAG / TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

M117A1 GP: 823 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(167-5)

Figure 2-72 (U) (Sheet 4 of 7)

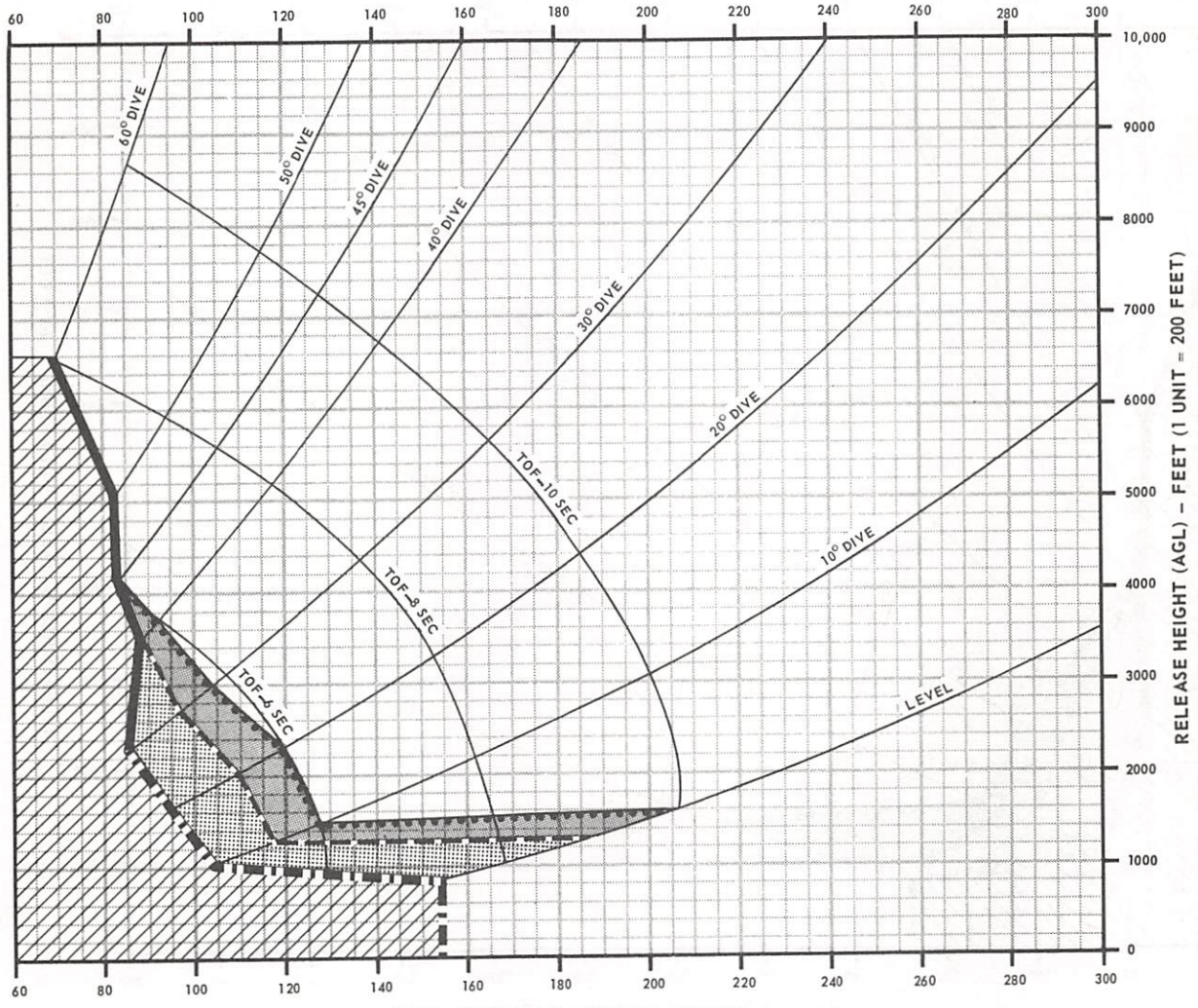
SIGHT ANGLE

M117A1 GP BOMB (M131 FIN)

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1600	206	1600	1325	189	1325	875	155	875
10	1500	128	1150	1300	117	950	1050	104	700
20	2300	119	1350	2025	109	1075	1675	96	725
30	3000	105	1200	2725	98	925	2300	86	500
40	3700	92	850	3550	89	700	3550	89	700
FRAG TERRAIN 45	4175	85	700	4175	85	700	4175	85	700
50	5125	84	1000	5125	84	1000	5125	84	1000
60	6600	70	1000	6600	70	1000	6600	70	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

M117A1 GP: 823 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(167-6)

Figure 2-72 (U) (Sheet 5 of 7)

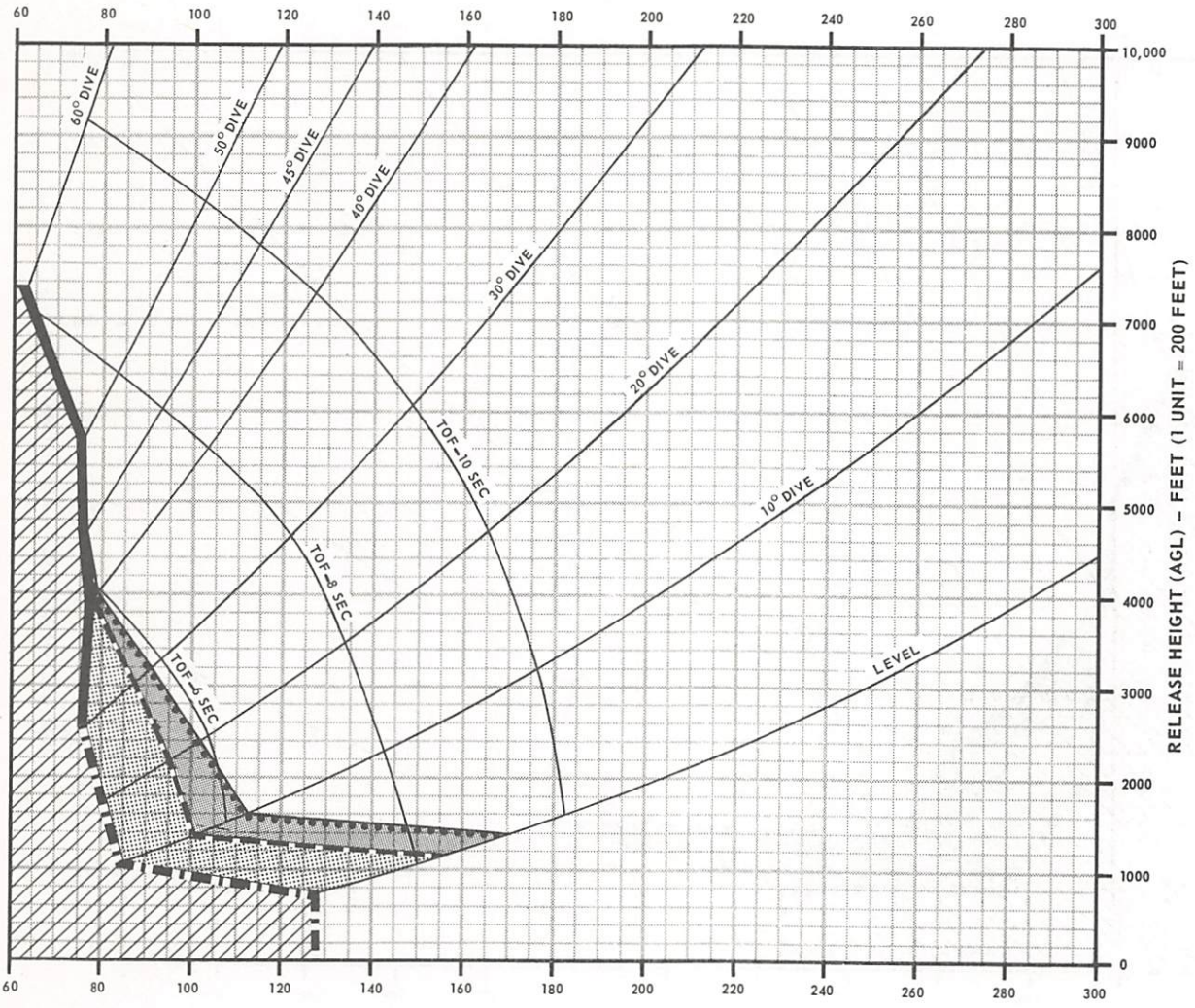
SIGHT ANGLE

M117A1 GP BOMB (M131 FIN)

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1400	171	1400	1175	157	1175	775	128	775
10	1600	112	1200	1375	101	975	1075	85	675
20	2400	101	1300	2200	95	1100	1775	81	675
30	3200	90	1150	3025	87	975	2550	76	500
40	4000	79	725	3975	78	700	3975	78	700
45	4675	77	700	4675	77	700	4675	77	700
50	5725	77	1000	5725	77	1000	5725	77	1000
60	7350	63	1000	7350	63	1000	7350	63	1000

NEW NEW NEW FRAG TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
M117A1 GP: 823 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(167-7)

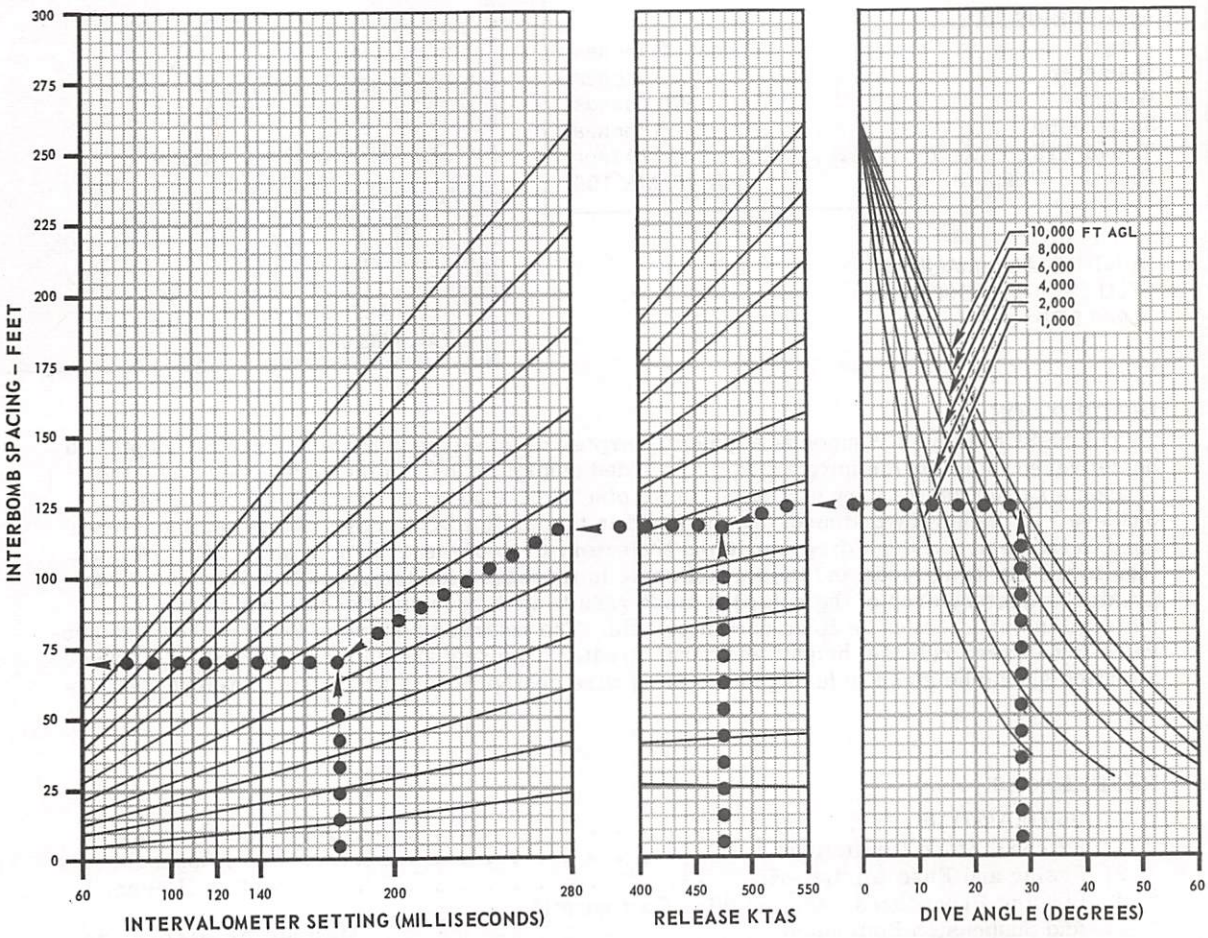
Figure 2-72 (U) (Sheet 6 of 7)

BOMB SPACING
M117A1 GP BOMB (M131 FIN)

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 4.2 FT/SEC)

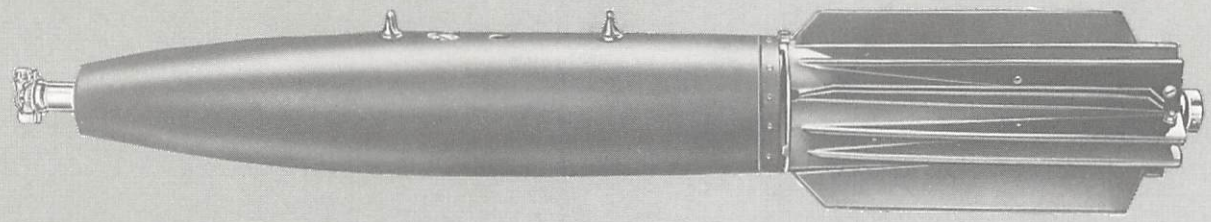


UNCLASSIFIED

FDB-1T-(167-8)

Figure 2-72 (U) (Sheet 7 of 7)

MK 81 SNAKEYE BOMB (250 LB)



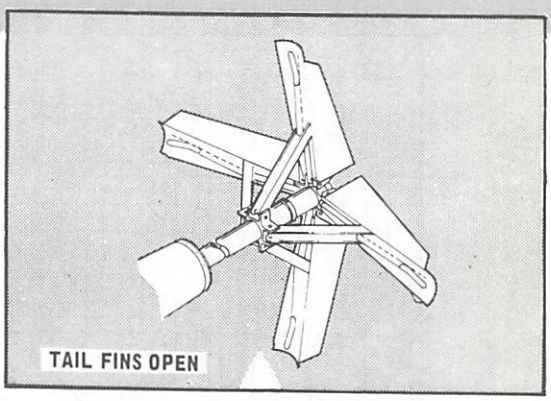
OD 170 A

CHARACTERISTICS

Length	6 Feet, 3 inches
Diameter	9 inches
Weight	300 pounds
Suspension	14.0 inches
Top of Frag Pattern	2470 feet
Practice Weapons	MK 76/MK 106

NEW

PAINTING AND MARKING:
YELLOW BAND ON OLIVE DRAB BODY.



DESCRIPTION

The Mk81 Snakeye I Weapon is a general purpose drogue type bomb which can be adapted to be delivered in either the unretarded or retarded configuration. In the unretarded mode the weapon's ballistics are very similar to those of a Mk81 LDGP. Delivery Data for the Mk81 Snakeye I in the unretarded mode can be found in the Mk81 LDGP tables of this section. When used in the retarded (high drag) mode the trajectory drop of the weapon is about 25% greater than in the low drag mode and the impact angle is increased for improved effectiveness. The greater trajectory drop of the retarded mode results in larger sight angles which can be so large in some tactics as to be uncomfortable. The retarded feature of Snakeye weapons provides for a lower release height and hence greater accuracy and delivery flexibility. Close attention should be given to fuzing and arming wire configurations when using Snakeye weapons.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-3.1

WARNING

Weapon fuzing and arming wire configuration must be in accordance with latest directives. A thorough preflight of the weapon is imperative.

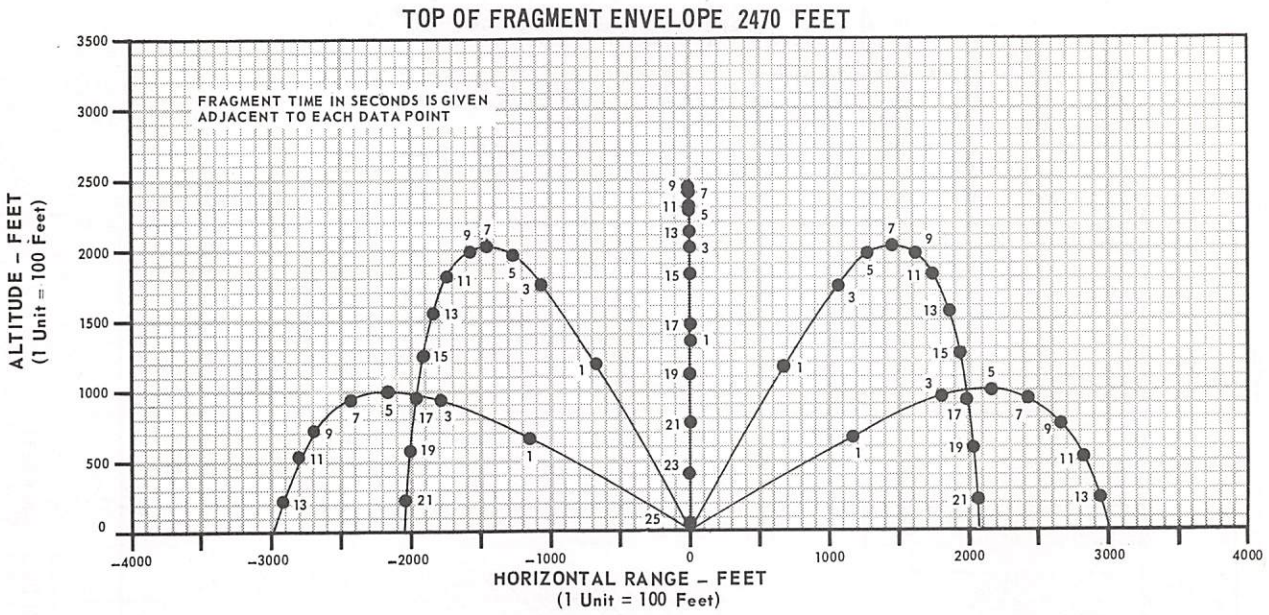
UNCLASSIFIED

FDB-1T-(168-1)

Figure 2-73 (U) (Sheet 1 of 7)

MAXIMUM FRAGMENT ENVELOPE
MK 81 BOMB

NEW NEW NEW NEW NEW NEW



UNCLASSIFIED

FDB–1T–(168–2)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 81 SNAKEYE-RETARDED

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT (Slant Range 1000 Ft)	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL		FT	MILS	FT	MILS
0°	100	450	23	–23	–1000	–	143	–318	18.0	–20.7	1.4	46	2.4	46	32.7
	300	450	27	–27	–490	430	142	–202	13.3	–14.2	2.0	87	6.3	85	42.6
10°	600	450	19	–19	–170	140	51	–63	6.5	–6.7	2.0	81	12.2	81	40.6
	1000	450	24	–24	–150	140	65	–76	6.5	–6.7	2.6	127	19.3	129	49.6
20°	1500	450	21	–21	–90	90	44	–49	5.0	–5.1	2.8	137	27.1	139	49.8

UNCLASSIFIED

FDB–1T–(168–3)

Figure 2-73 (U) (Sheet 2 of 7)

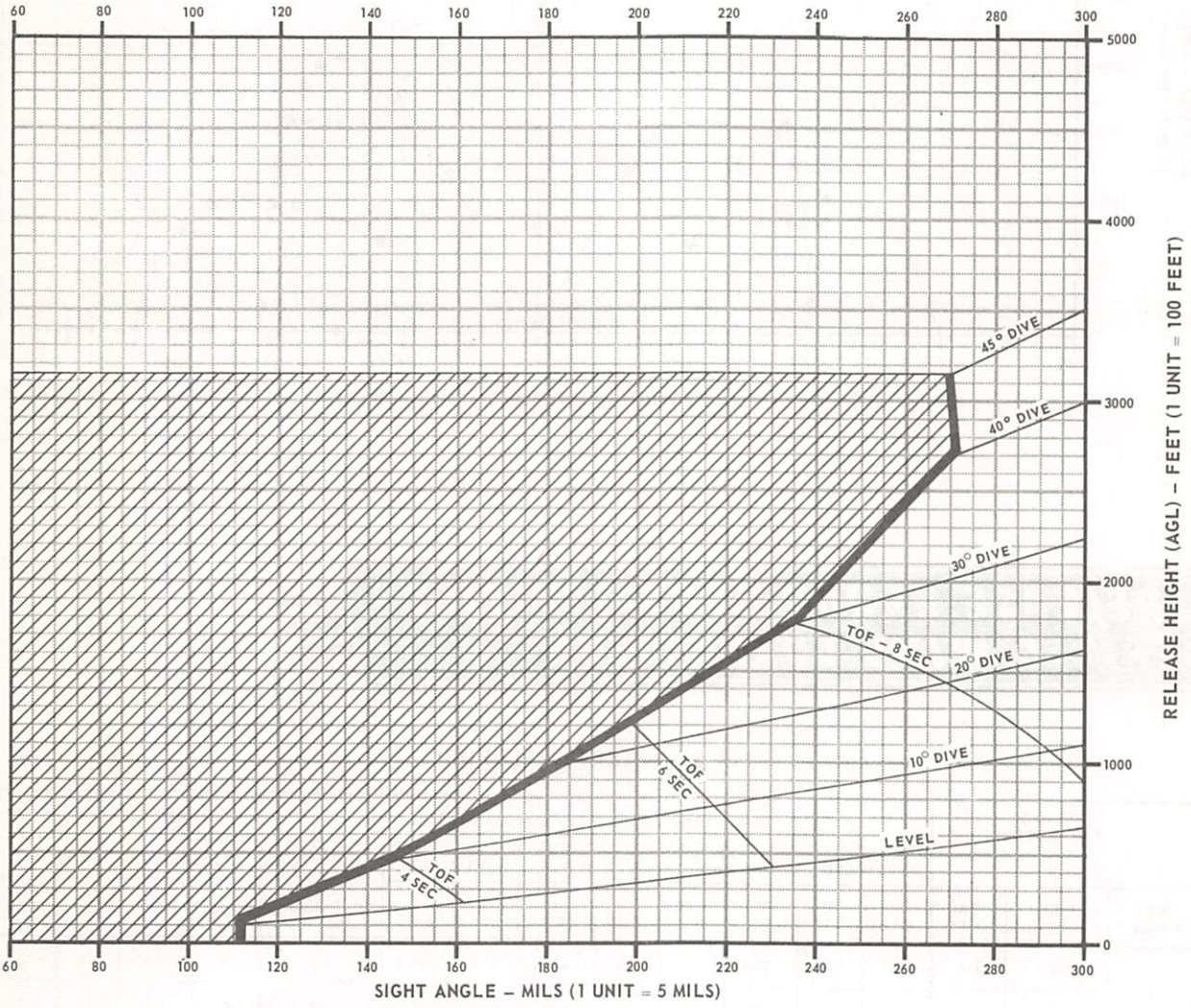
SIGHT ANGLE

MK 81 SNAKEYE-RETARDED

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY (FT)
0	100	111	100
10	475	147	200
20	1000	185	300
30	1775	236	500
40	2725	272	700
45	3150	270	700

WEAPONS BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(168-4)

Figure 2-73 (U) (Sheet 3 of 7)

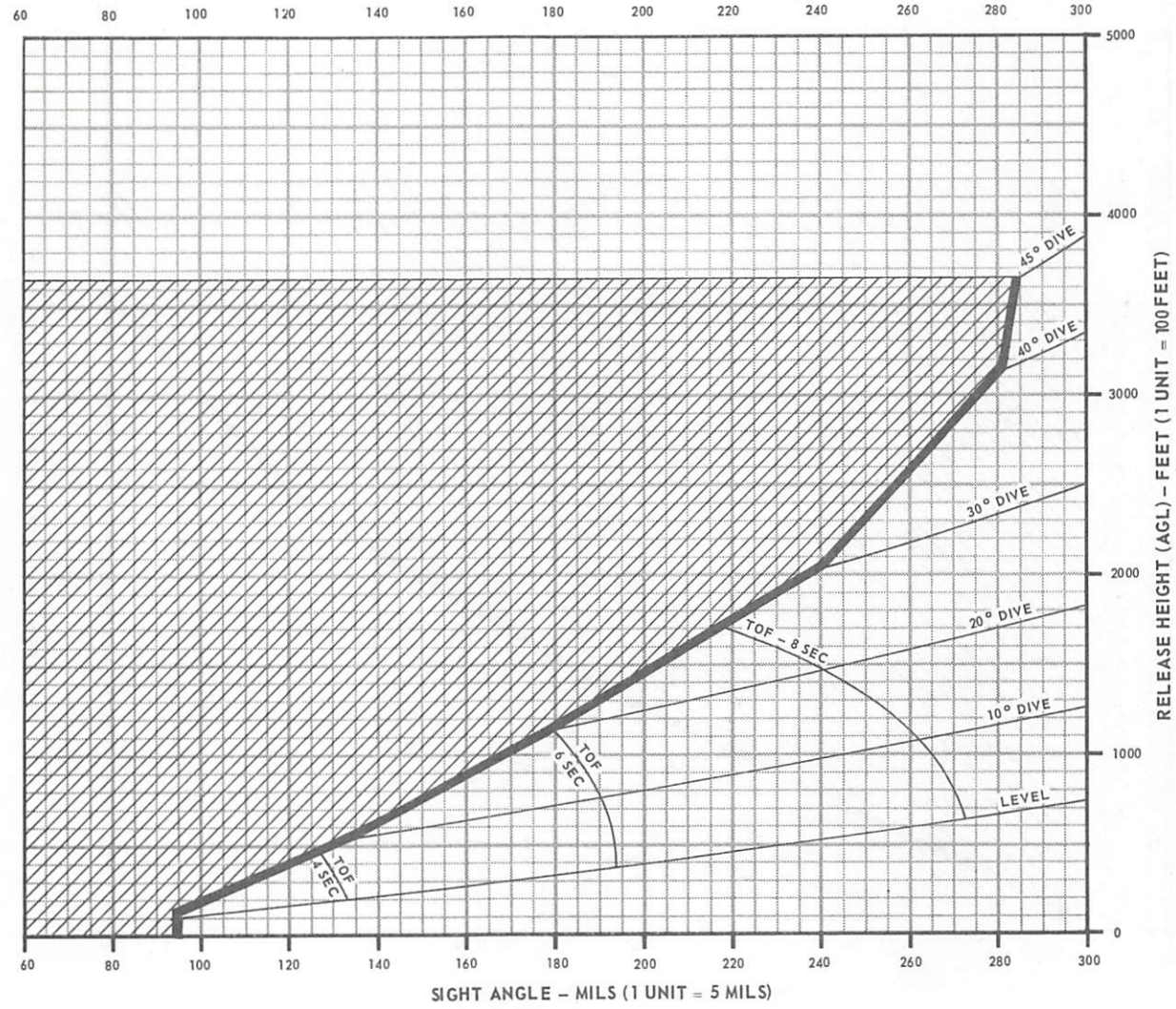
SIGHT ANGLE

MK81 SNAKEYE-RETARDED

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY (FT)
0	100	94	100
10	525	135	200
20	1125	181	300
30	2025	241	500
40	3125	283	700
45	3650	285	700

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(168-5)

Figure 2-73 (U) (Sheet 4 of 7)

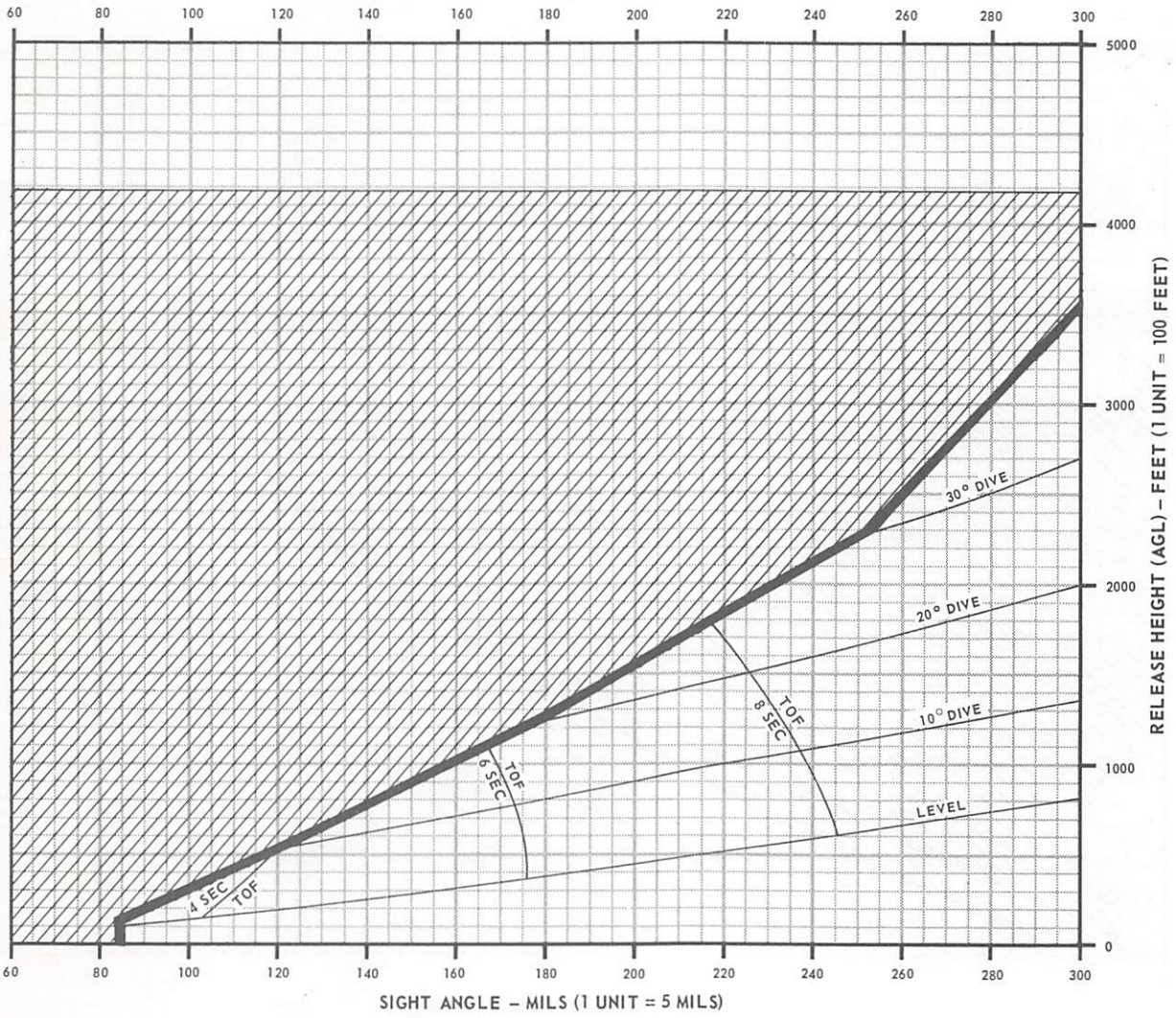
SIGHT ANGLE

MK81 SNAKEYE-RETARDED

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED I MMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV–ERY (FT)
0	100	83	100
10	550	124	200
20	1250	181	300
30	2300	254	500
40	3550	301	700
45	4175	305	700

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

NEW NEW NEW

UNCLASSIFIED

FDB–1T–(168–6)

Figure 2-73 (U) (Sheet 5 of 7)

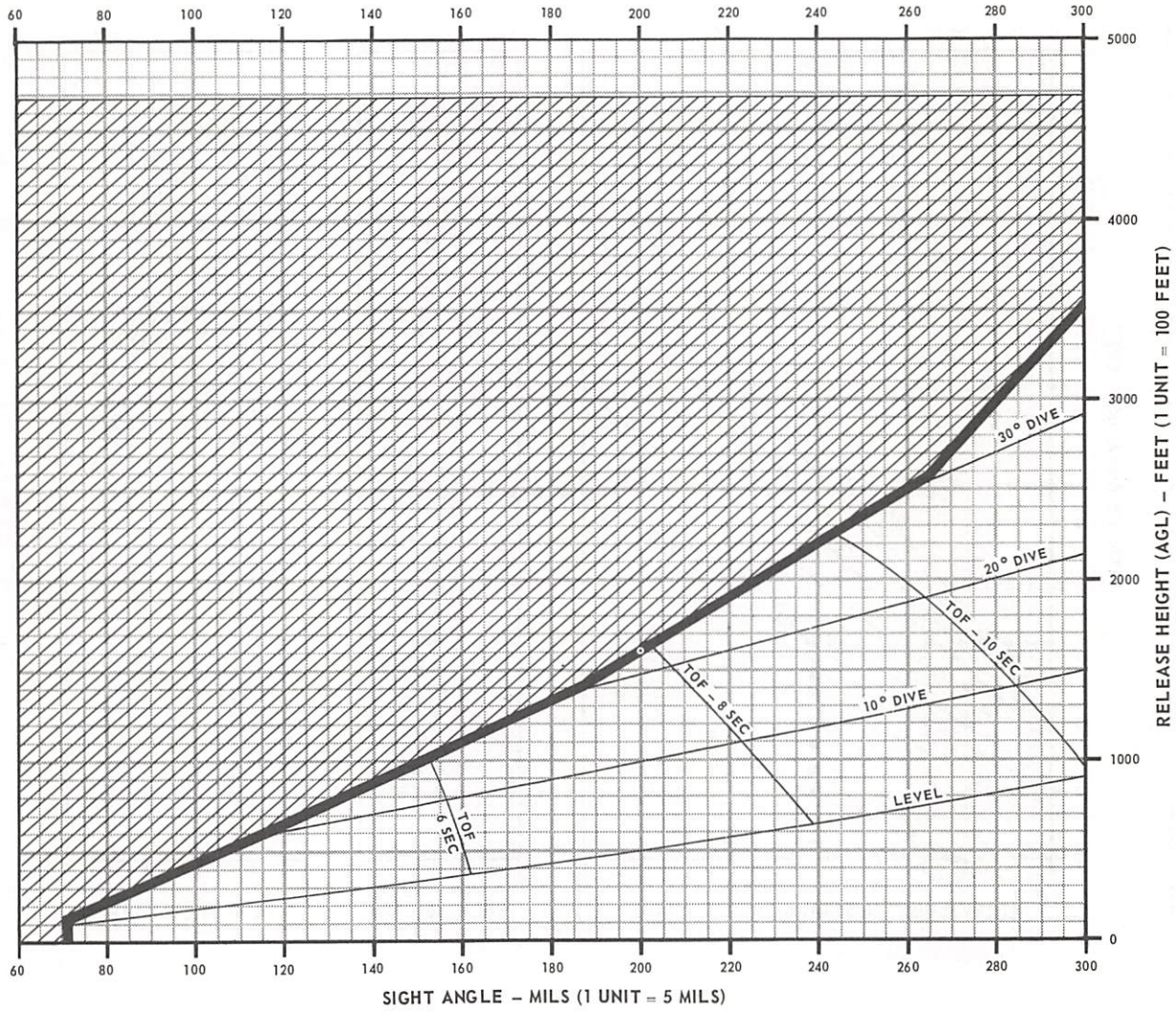
SIGHT ANGLE

MK 81 SNAKEYE-RETARDED

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED I MEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	71	100
10	600	118	200
20	1400	188	300
30	2550	265	500
40	3975	317	700
45	4675	322	700

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(16R-7)

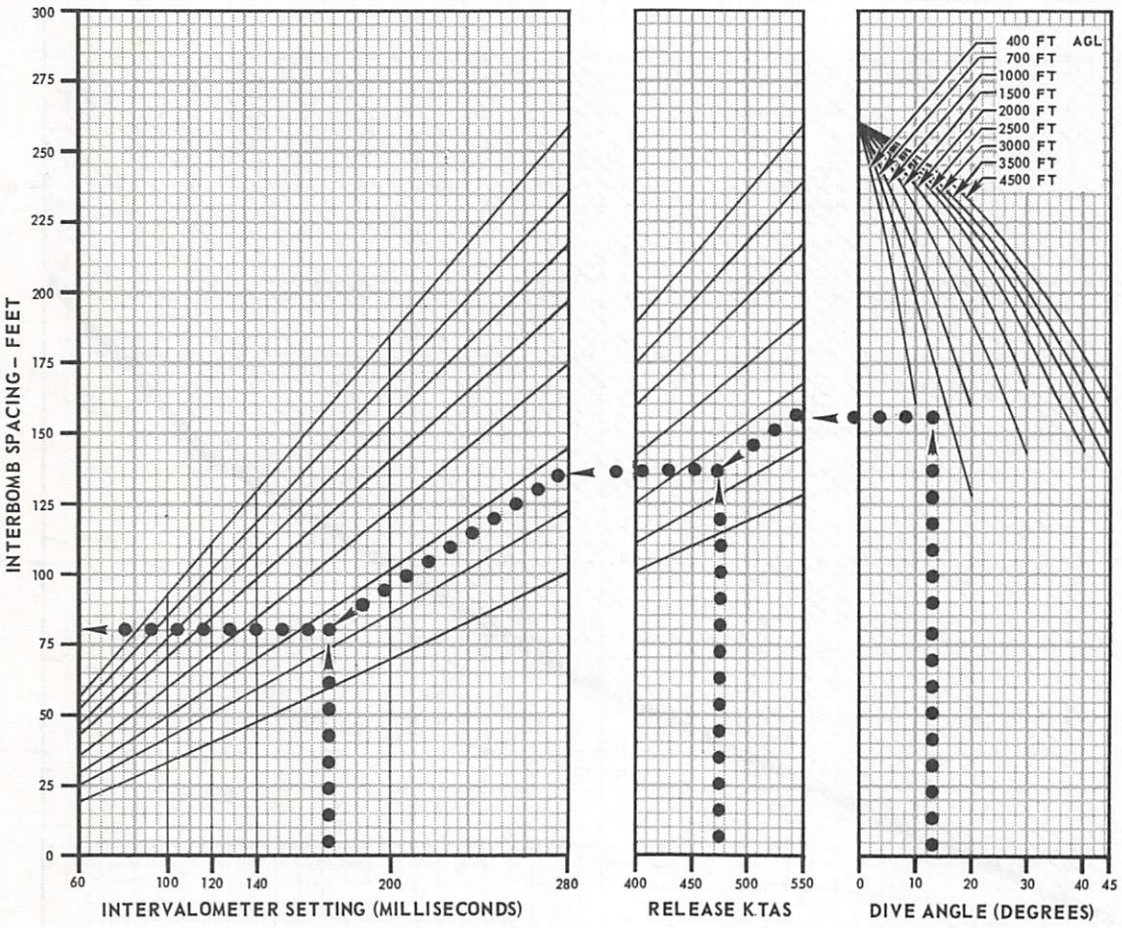
Figure 2-73 (U) (Sheet 6 of 7)

BOMB SPACING
MK 81 SNAKEYE-RETARDED

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 7.2 FT/SEC)



UNCLASSIFIED

FDB-1T-(168-8)

Figure 2-73 (U) (Sheet 7 of 7)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 81 SNAKEYE-UNRETARDED (Release from MER/TER Racks)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	1500	450	144	-144	-240	230	264	-347	31.7	-33.2	7.0	165	5.1	165	23.5
10°	1600	450	65	- 67	-100	90	83	-104	15.6	-16.1	5.0	114	7.2	113	22.7
20°	2000	450	37	- 38	- 40	40	36	- 42	9.6	- 9.8	4.4	98	10.1	98	22.2
30°	3000	450	32	- 33	- 30	20	27	- 30	8.3	- 8.4	5.0	109	13.1	109	21.8
	5000	500	52	- 54	- 30	30	51	- 57	12.7	-12.9	8.0	157	12.3	158	19.7
45°	4000	450	21	- 22	- 10	10	18	- 19	6.7	- 6.7	5.2	110	16.4	110	21.2
	6000	500	31	- 32	- 10	10	31	- 33	9.7	- 9.8	7.7	146	15.0	148	19.2
60°	7000	500	19	- 20	- 10	10	23	- 25	8.6	- 8.6	7.7	146	17.0	145	18.8

UNCLASSIFIED

FDB-1T-(169-1)

Figure 2-74 (U) (Sheet 1 of 6)

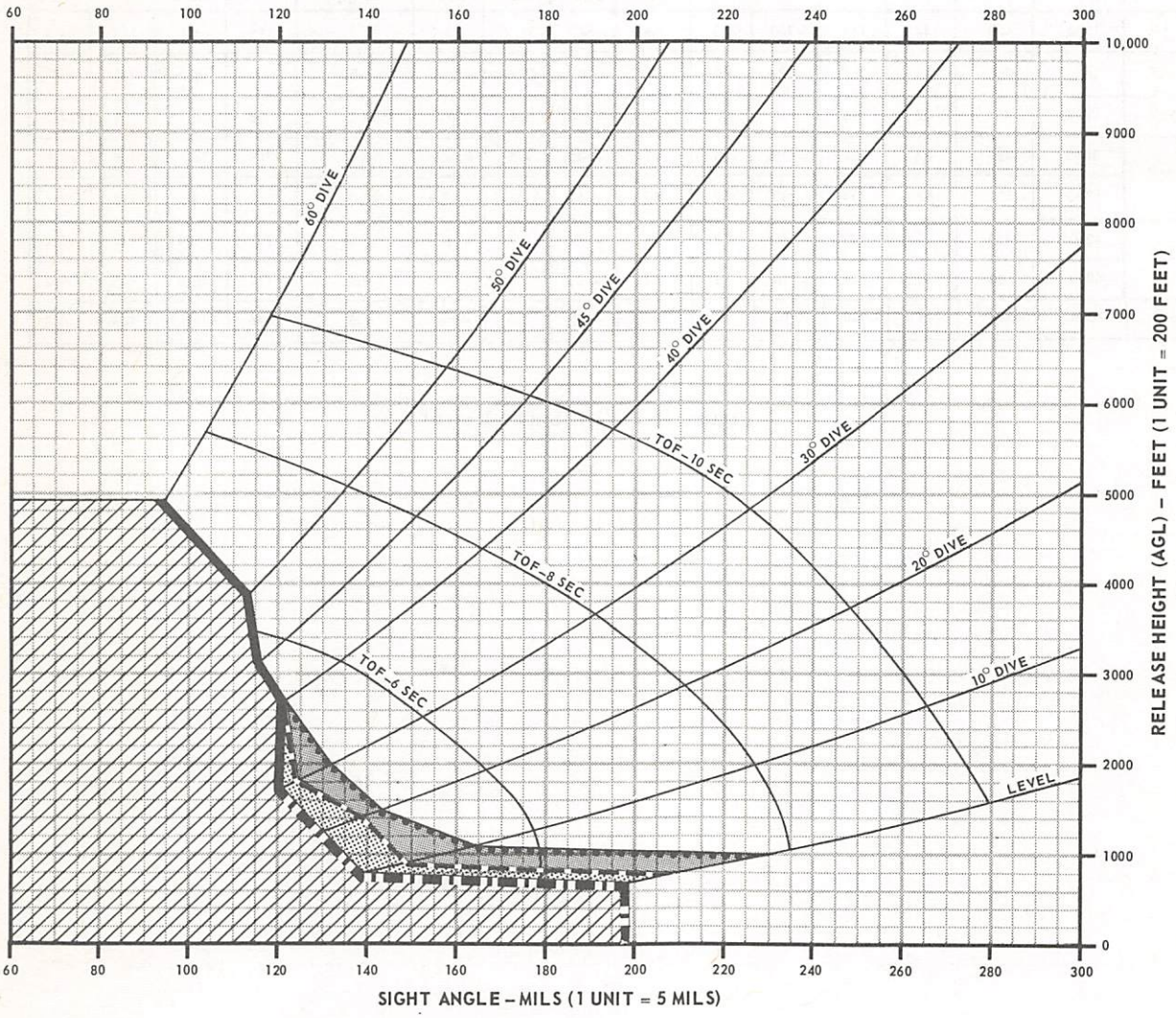
SIGHT ANGLE

MK81 SNAKEYE-UNRETARDED

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1000	227	1000	800	206	800	725	198	725
10	1100	163	825	925	148	650	825	139	550
20	1500	143	800	1425	139	725	1275	130	575
30	2000	130	725	1825	123	550	1775	121	500
40	2725	121	700	2725	121	700	2725	121	700
45	3150	116	700	3150	116	700	3150	116	700
50	3925	114	1000	3925	114	1000	3925	114	1000
60	4950	94	1000	4950	94	1000	4950	94	1000

FRAG
TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(169-2)

Figure 2-74 (U) (Sheet 2 of 6)

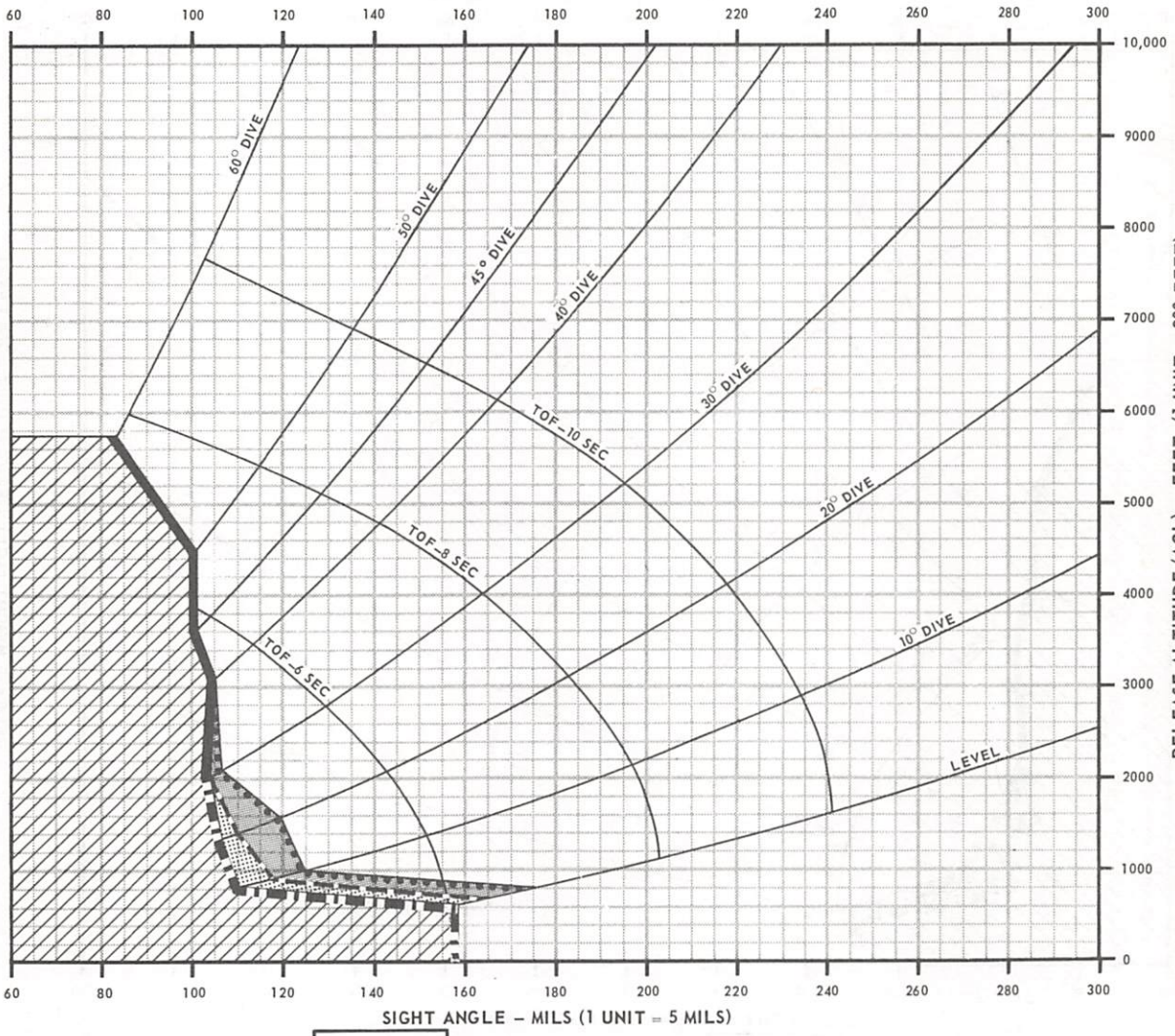
SIGHT ANGLE

MK81 SNAKEYE-UNRETARDED

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	800	175	800	700	165	700	625	158	625
10	1000	126	675	900	118	575	850	115	525
20	1600	119	775	1400	110	575	1350	107	525
30	2100	107	575	2025	104	500	2025	104	500
FRAG TERRAIN 40	3125	105	700	3125	105	700	3125	105	700
45	3650	100	700	3650	100	700	3650	100	700
50	4525	100	1000	4525	100	1000	4525	100	1000
60	5750	83	1000	5750	83	1000	5750	83	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(169-3)

Figure 2-74 (U) (Sheet 3 of 6)

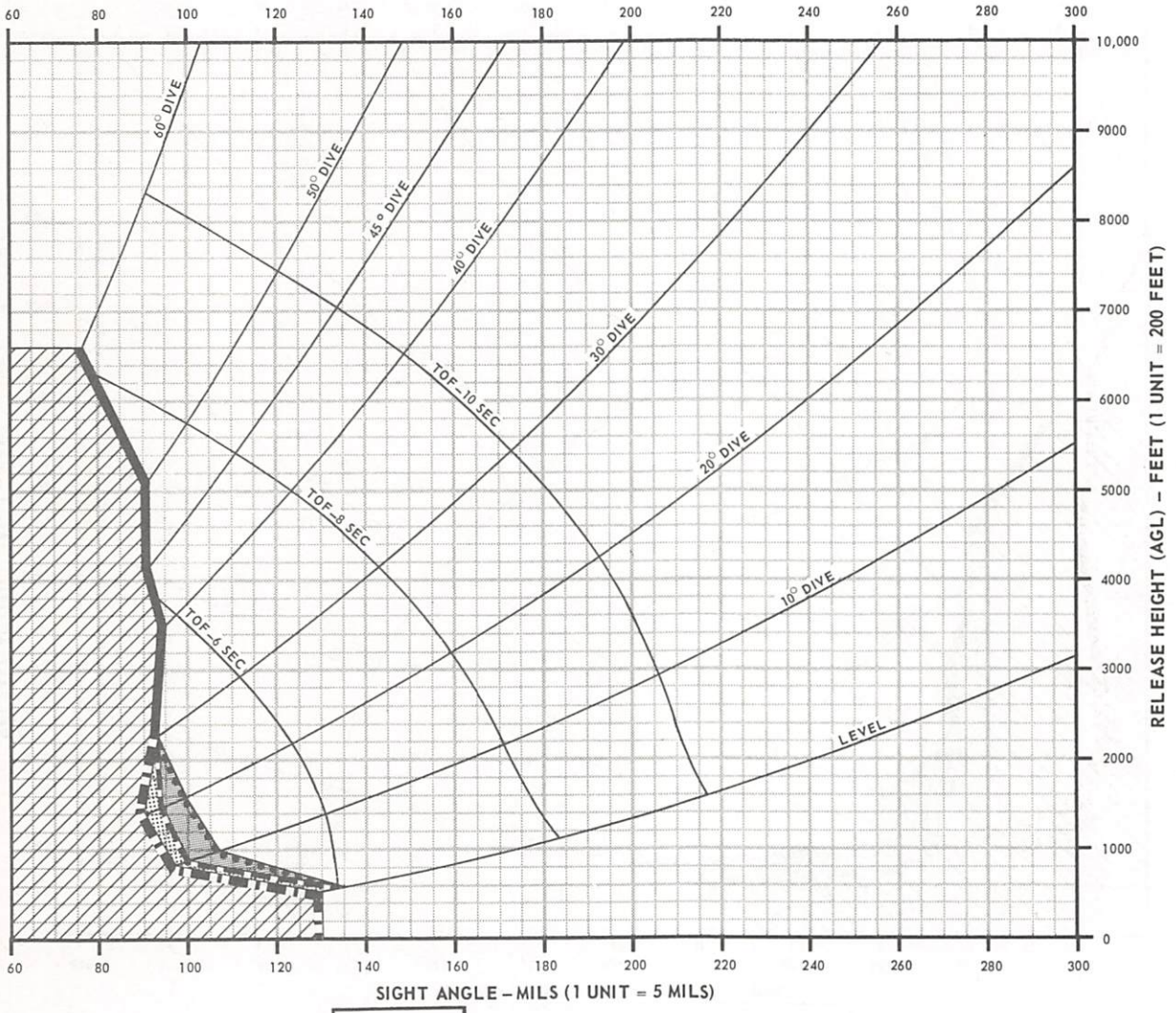
SIGHT ANGLE

MK81 SNAKEYE-UNRETARDED

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	600	135	600	600	135	600	550	130	550
10	1000	105	650	925	99	575	875	96	525
20	1600	98	650	1475	93	525	1400	90	450
FRAG / TERRAIN 30	2300	92	500	2300	92	500	2300	92	500
40	3550	95	700	3550	95	700	3550	95	700
45	4175	91	700	4175	91	700	4175	91	700
50	5125	90	1000	5125	90	1000	5125	90	1000
60	6600	76	1000	6600	76	1000	6600	76	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(169-4)

Figure 2-74 (U) (Sheet 4 of 6)

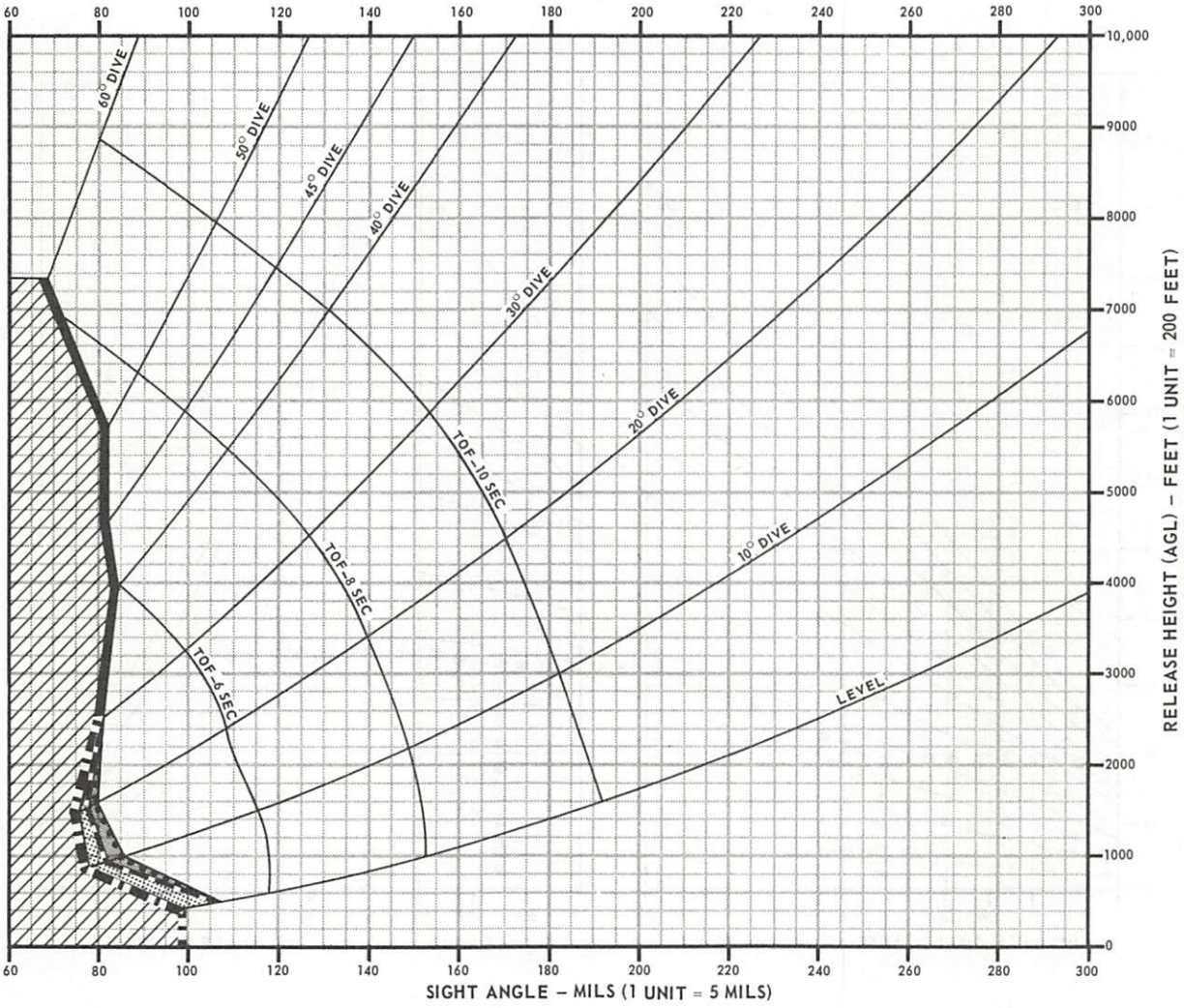
SIGHT ANGLE

MK81 SNAKEYE-UNRETARDED

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	500	107	500	500	107	500	425	99	425
10	1000	86	600	950	83	550	875	78	475
20	1600	79	500	1550	78	450	1475	76	375
FRAG / TERRAIN									
30	2550	81	500	2550	81	500	2550	81	500
40	3975	84	700	3975	84	700	3975	84	700
45	4675	82	700	4675	82	700	4675	82	700
50	5725	82	1000	5725	82	1000	5725	82	1000
60	7350	68	1000	7350	68	1000	7350	68	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 81 SNAKEYE: 300 LBS/7.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(169-5)

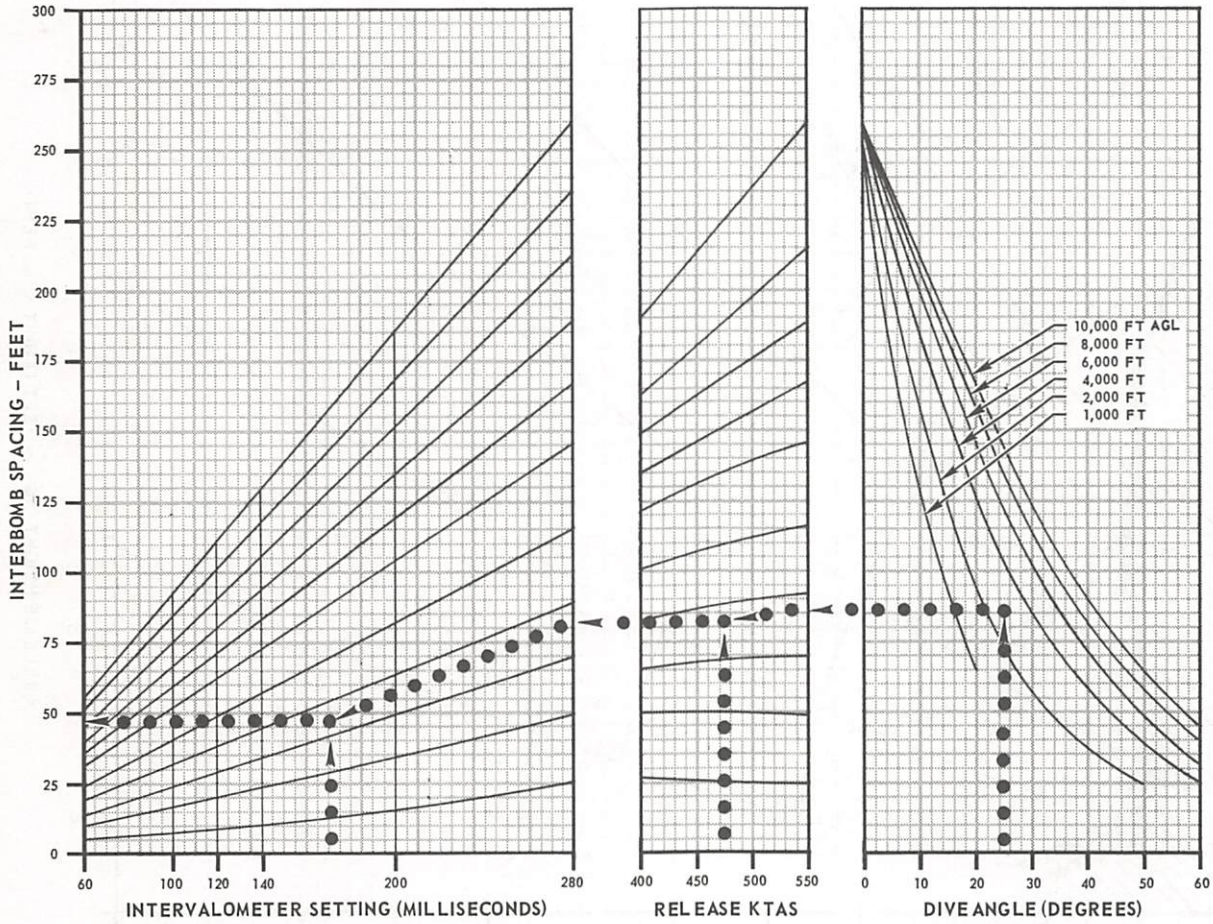
Figure 2-74 (U) (Sheet 5 of 6)

BOMB SPACING
MK81 SNAKEYE-UNRETARDED

Notes

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 7.2 FT/SEC)

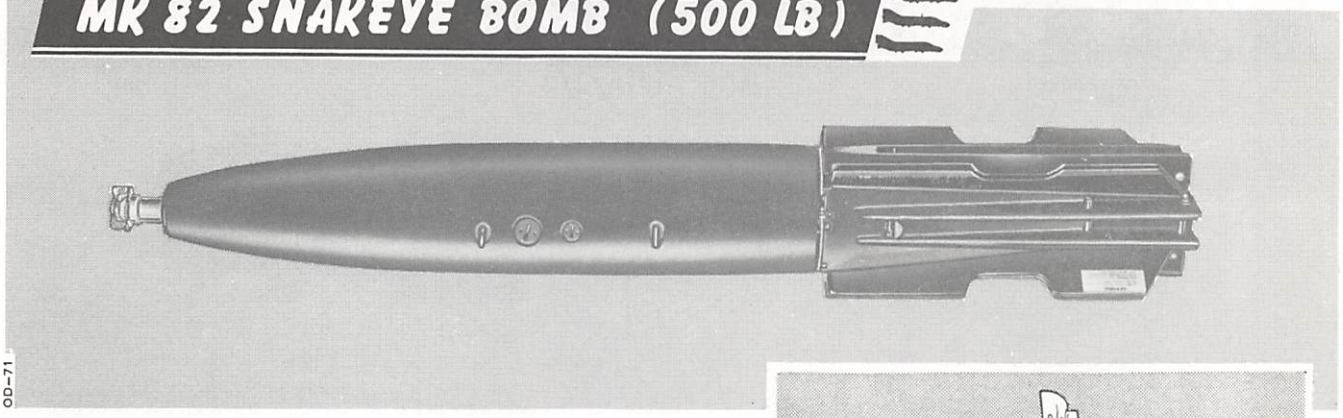


UNCLASSIFIED

FDB-1T-(169-6)

Figure 2-74 (U) (Sheet 6 of 6)

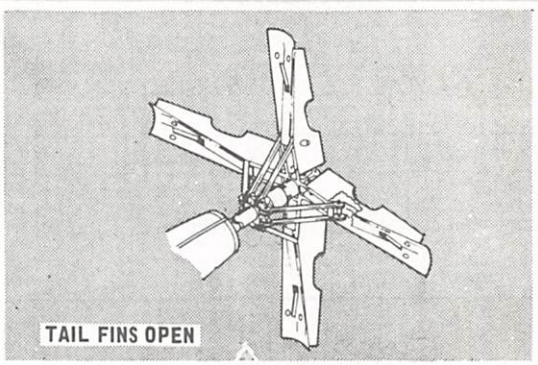
MK 82 SNAKEYE BOMB (500 LB)



OD-71

LENGTH	7 FEET, 5 INCHES
DIAMETER	10.8 INCHES
WEIGHT	570 POUNDS
TOP OF FRAG PATTERN	2520 FEET

NEW



PAINTING AND MARKING:
YELLOW BAND ON OLIVE DRAB BODY.

DESCRIPTION

The MK 82 Snakeye I Weapon is a general purpose drogue type bomb which can be adapted to be delivered in either the unretarded or retarded configuration. In the unretarded mode the weapon's ballistics are very similar to those of a MK 82 LDGP. Delivery Data for the MK 82 Snakeye I in the unretarded mode can be found in the MK 82 LDGP tables of this section. When used in the retarded (high drag) mode the trajectory drop of the weapon is about 25% greater than in the low drag mode and the impact angle is increased for improved effectiveness. The greater trajectory drop of the retarded mode results in larger sight depression which can be so large in some tactics as to be uncomfortable. The retarded feature of Snakeye weapons provides for a lower release altitude and hence greater accuracy and delivery flexibility. Close attention should be given to fuzing and arming wire configurations when using Snakeye weapons.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-3.1

WARNING

Weapon fuzing and arming wire configuration must be in accordance with latest directives. A thorough preflight of the weapon is imperative.

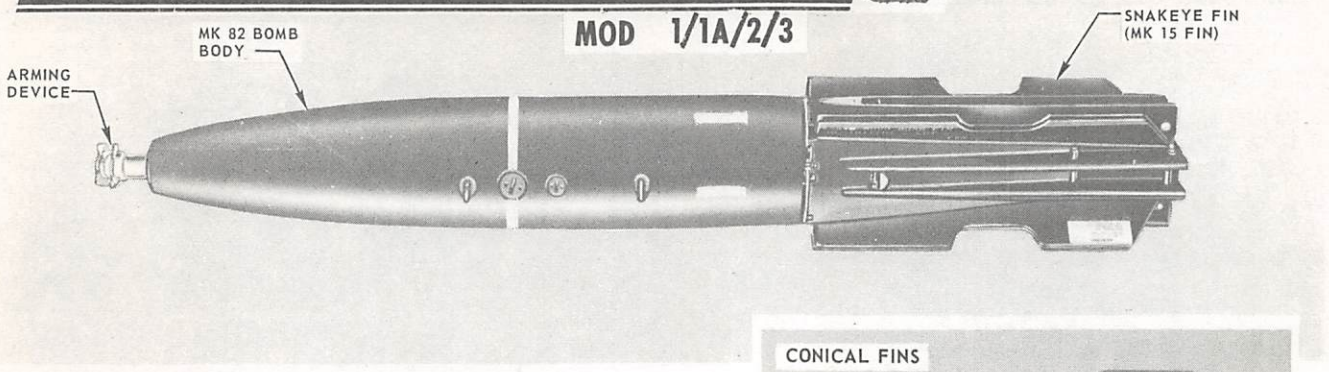
UNCLASSIFIED

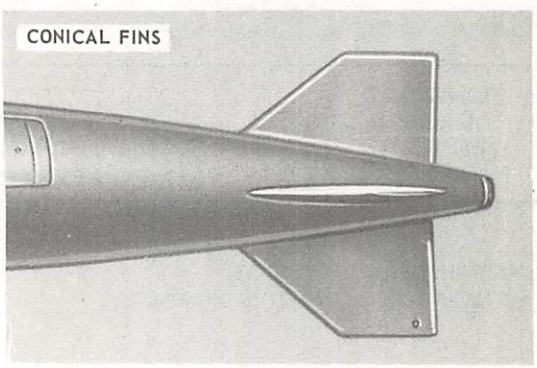
FDB-1T-(170-1)

Figure 2-75 (U) (Sheet 1 of 9)

MK 36 DESTRUCTOR (500 LB)

MOD 1/1A/2/3





CHARACTERISTICS	CONICAL FIN	SNAKEYE FIN
LENGTH	7 FT, 2 INCHES	7 FEET, 5.3 INCHES
DIAMETER (BODY)	10.8 INCHES	10.8 INCHES
(FINS WHEN CLOSED)	15.1 INCHES	15.1 INCHES
WEIGHT	531 POUNDS	570 POUNDS
SUSPENSION	14 INCHES	14 INCHES
TOP OF FRAG PATTERN	2520 FEET	2520 FEET

NEW

PAINTING/MARKINGS

Yellow bands on olive drab body.

White stripe around mid-section and four six-inch horizontal stripes spaced around after end of bomb casing.

Mk 30 nose arming device is green; Mk 32 arming device is gold. Tail firing mechanism is black with a gold flange.

COMPONENTS OF COMPLETE WEAPON		
	MK 36 MOD 1	MK 36 MOD 1A/2/3
BOMB BODY	MK 82	MK 82
FIN ASSEMBLY	MK 15 MOD 1/2	MK 15 MOD 1/2 OR CONICAL
ARMING DEVICE	MK 30	MK 32
FIRING MECHANISM	MK 42 MOD 1	MK 42 MOD 1/2/3
AUTHORIZED DELIVERY MODES	RETARDED ONLY	RETARDED AND UNRETARDED

DESCRIPTION

The Mk 36 Destructor consists of a Mk 82 bomb fitted with a nose arming device and a tail firing mechanism that allows the weapon to function as a magnetic influence weapon for use against shallow water and land targets. The Destructor Modification Kit Mk 75 provides the special arming and firing mechanisms. See Fuzing Section and NAVORD OP 3529 for details of these mechanisms. Delivery data and Sights settings are the same as for Mk 82 bomb in similar configurations.

REFERENCES

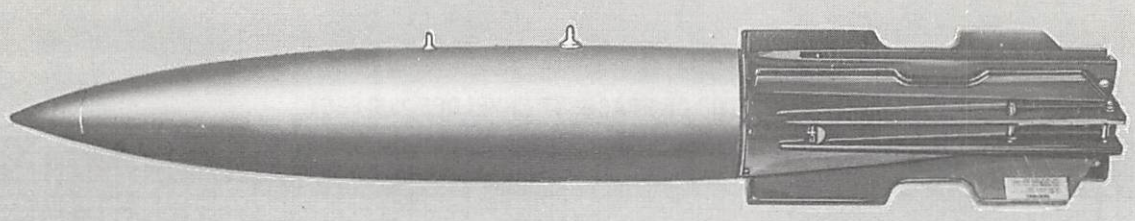
1. Bomb Assembly . . . . . NAVORD OP 3529
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations . . . . . Section II, Part I
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment . . . . . NAVAIR 01-245FDB-75
5. Current AAB's . . . . .
6. Stores Reliability Card . . . . . (CONICAL FIN) NAVAIR 01-245FD-75-2.2
   (SNAKEYE FIN) NAVAIR 01-245FD-75-3.2

CONFIDENTIAL

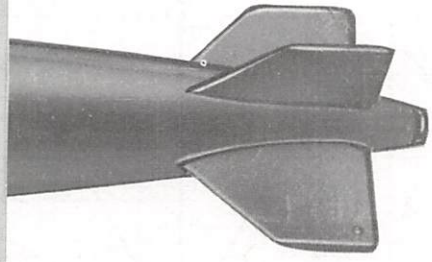
FDB-1T-(170-2)

Figure 2-75 (C) (Sheet 2 of 9)

MK 124 PRACTICE BOMB (500-LB)



CONICAL FIN



CHARACTERISTICS	
LENGTH	7 FEET, 5 INCHES
DIAMETER (BODY)	10.8 INCHES
(FINS WHEN CLOSED)	15.1 INCHES
WEIGHT (SNAKEYE FIN)	565 POUNDS
(CONICAL FIN)	525 POUNDS
SUSPENSION	14 INCHES

COMPONENTS OF PRACTICE BOMB

BOMB BODY	MK 124 Mod 0
FIN ASSEMBLY	MK 15 Mod 1 (Snakeye) or Conical Fin
TAIL FUZE	M990 (Electrical)

DESCRIPTION

The MK 124 practice bomb is filled with concrete by the manufacturer. The bomb contains the necessary cable assembly to accommodate the M990 electric tail fuze. Delivery data for the MK 124 practice bomb is the same as MK 82 data with the same fin configuration.

REFERENCES

1.	Bomb Assembly	NAVAIR 11-5A-17
2.	External Store Limitation	Appendix A
3.	Fuzing and Fuze Limitations	Section II, Part 1
4.	Loading Procedures, Arming Wire Configuration, and Suspension Equipment	NAVAIR 01-245FDB-75
5.	Stores Reliability Card	NAVAIR 01-245FD-75-3.4
6.	Current AAB's.	

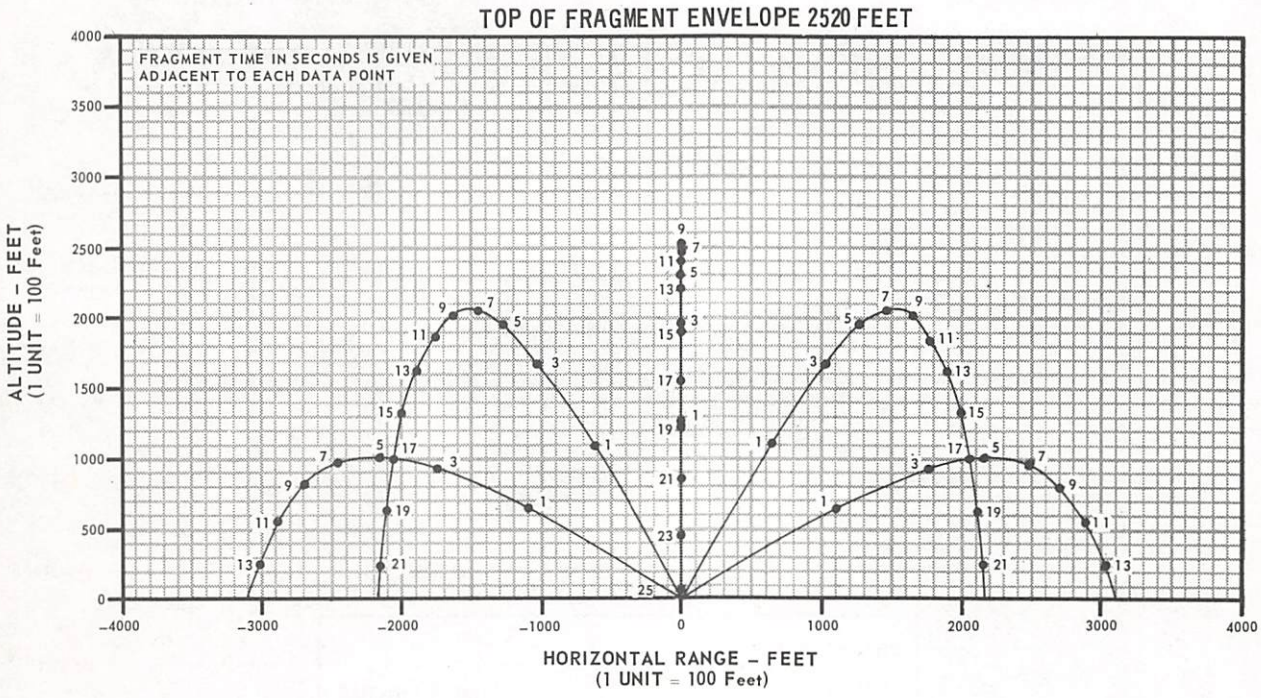
UNCLASSIFIED

FDB-1T-(170-3)

Figure 2-75 (U) (Sheet 3 of 9)

MAXIMUM FRAGMENT ENVELOPE

MK 82 BOMB



UNCLASSIFIED

FDB–1T–(170–4)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-RETARDED

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)								RELATIVE WIND –10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE	ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE (DEG)	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL	Slant Range 1000 FT	FT	MILS	FT	MILS
0	200	450	27	–27	–670	510	161	–275	17.7	–19.5	1.9	67	3.6	66	34.6
	500	450	30	–31	–370	340	150	–197	13.9	–14.1	2.6	112	8.0	110	42.3
10	800	450	21	–22	–160	140	61	– 74	7.6	– 7.8	2.5	97	12.6	98	39.1
	1500	450	28	–28	–130	130	79	– 90	7.7	– 7.8	3.4	164	21.1	163	47.9
20	2000	450	23	–24	– 80	80	54	– 60	6.2	– 6.2	3.5	164	26.4	162	46.4
30	3000	450	22	–23	– 60	60	48	– 52	5.8	– 5.8	4.2	202	34.8	203	48.3

UNCLASSIFIED

FDB–1T–(170–5)

Figure 2-75 (U) (Sheet 4 of 9)

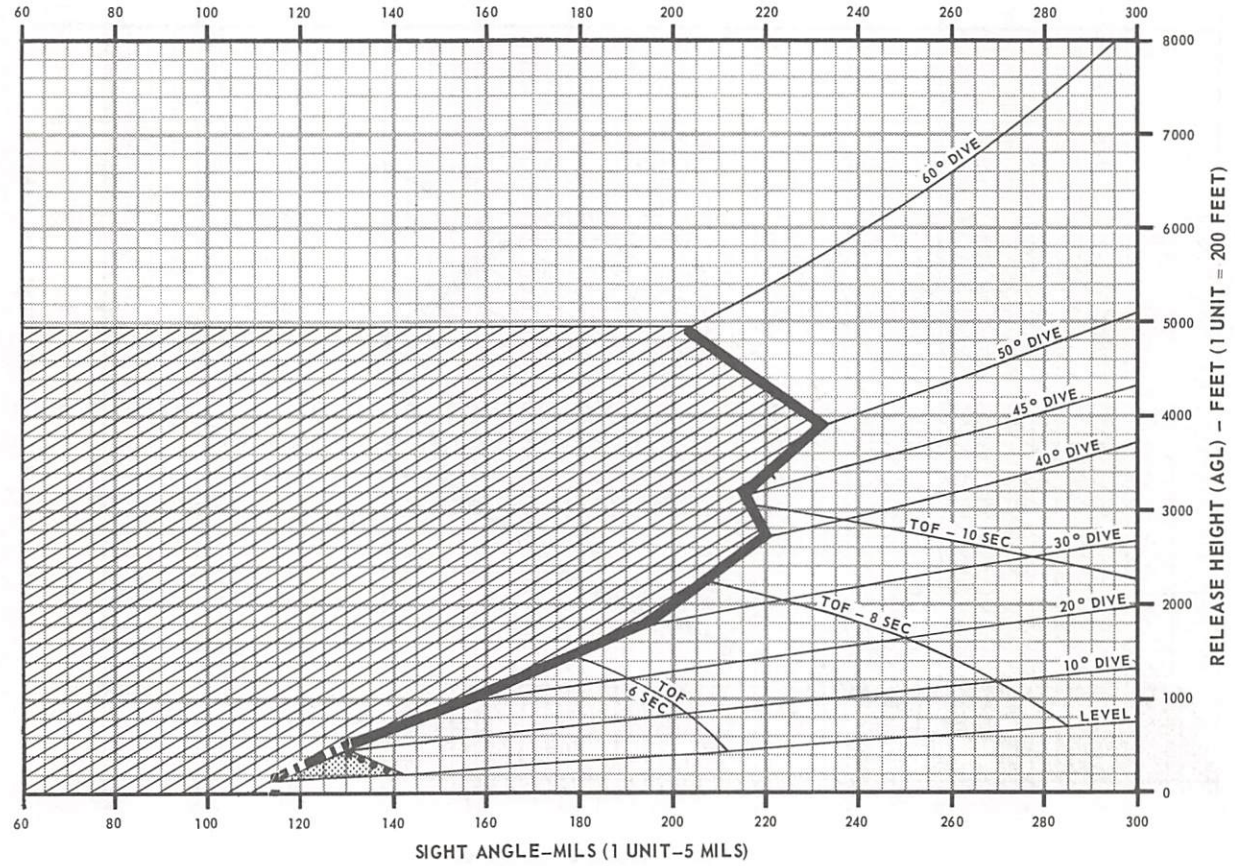
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-RETARDED

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

	DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
		0.000			0.001			0.010		
		MIN. REL.	SIGHT ANGLE	RECOV. ERY	MIN. REL.	SIGHT ANGLE	RECOV. ERY	MIN. REL.	SIGHT ANGLE	RECOV. ERY
FRAG	0	200	142	200	200	142	200	125	115	125
TERRAIN	10	475	131	200	475	131	200	475	131	200
	20	1000	159	300	1000	159	300	1000	159	300
	30	1775	196	500	1775	196	500	1775	196	500
	40	2725	221	700	2725	221	700	2725	221	700
	45	3150	220	700	3150	220	700	3150	220	700
	50	3925	234	1000	3925	234	1000	3925	234	1000
	60	4950	204	1000	4950	204	1000	4950	204	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 570 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(170-6)

Figure 2-75 (U) (Sheet 5 of 9)

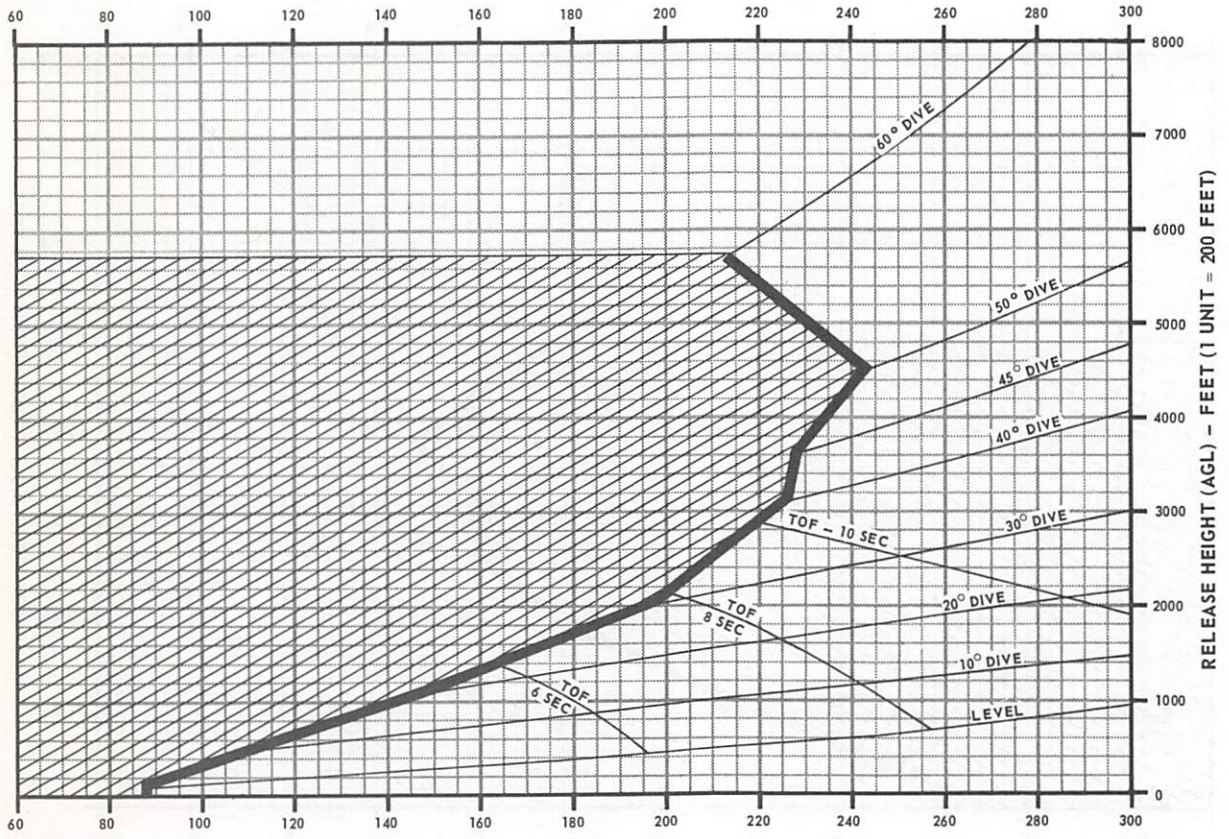
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-RETARDED

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	Height in Feet AGL		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	100	88	100
10	525	118	200
20	1125	151	300
30	2025	196	500
40	3125	227	700
45	3650	229	700
50	4525	244	1000
60	5750	214	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 570 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(170-7)

Figure 2-75 (U) (Sheet 6 of 9)

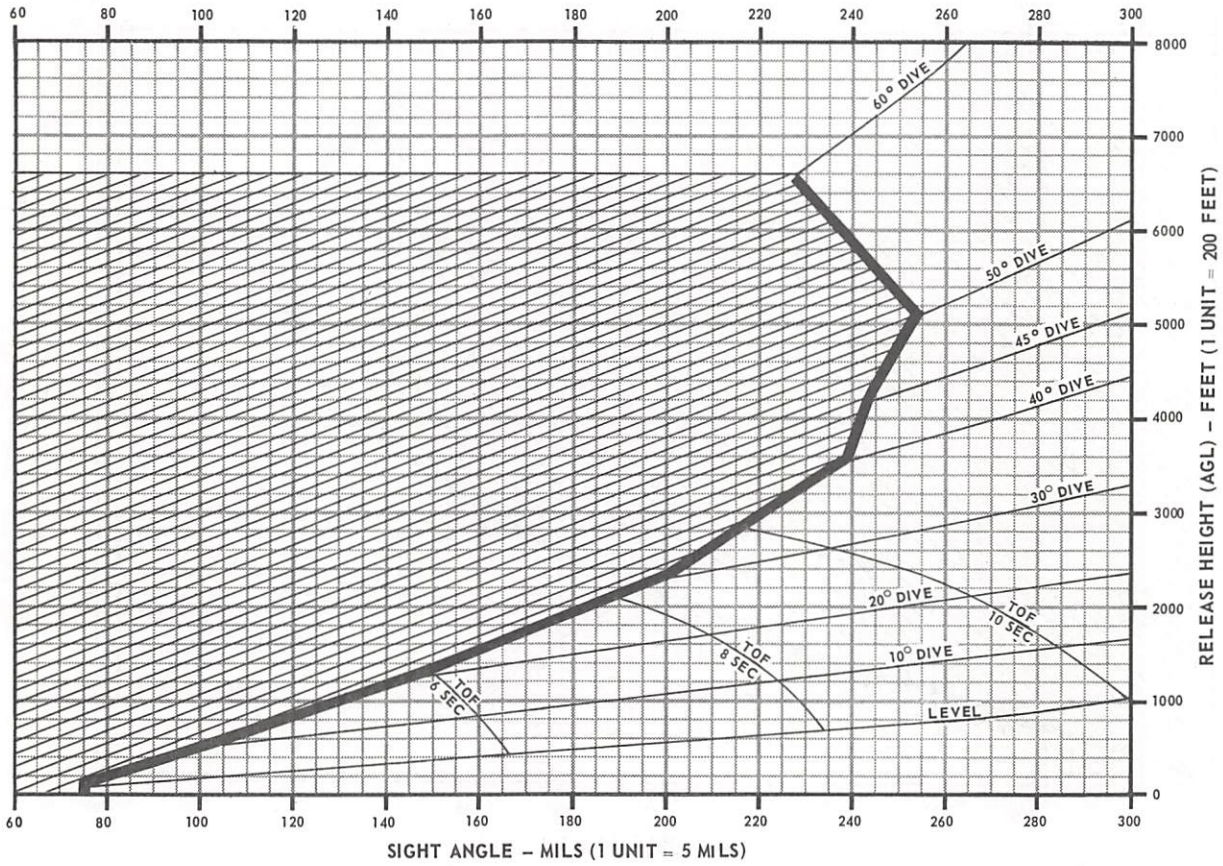
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-RETARDED

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	Height in Feet AGL		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	100	76	100
10	550	105	200
20	1250	148	300
30	2300	202	500
40	3550	240	700
45	4175	244	700
50	5125	255	1000
60	6600	227	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 570 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(170-8)

Figure 2-75 (U) (Sheet 7 of 9)

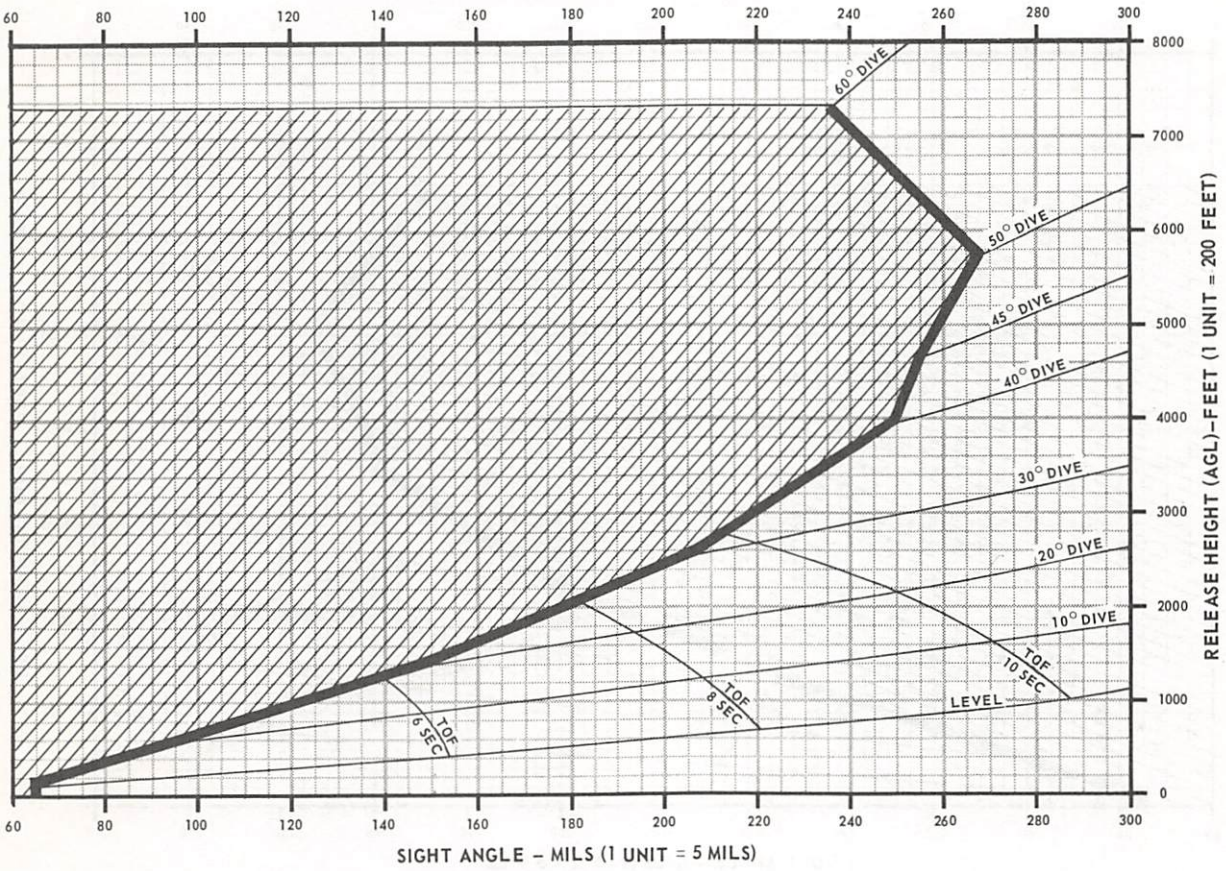
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-RETARDED

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED I MEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	Height in Feet AGL		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	100	66	100
10	600	99	200
20	1400	150	300
30	2550	208	500
40	3975	251	700
45	4675	256	700
50	5725	269	1000
60	7350	237	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 570 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(170-9)

Figure 2-75 (U) (Sheet 8 of 9)

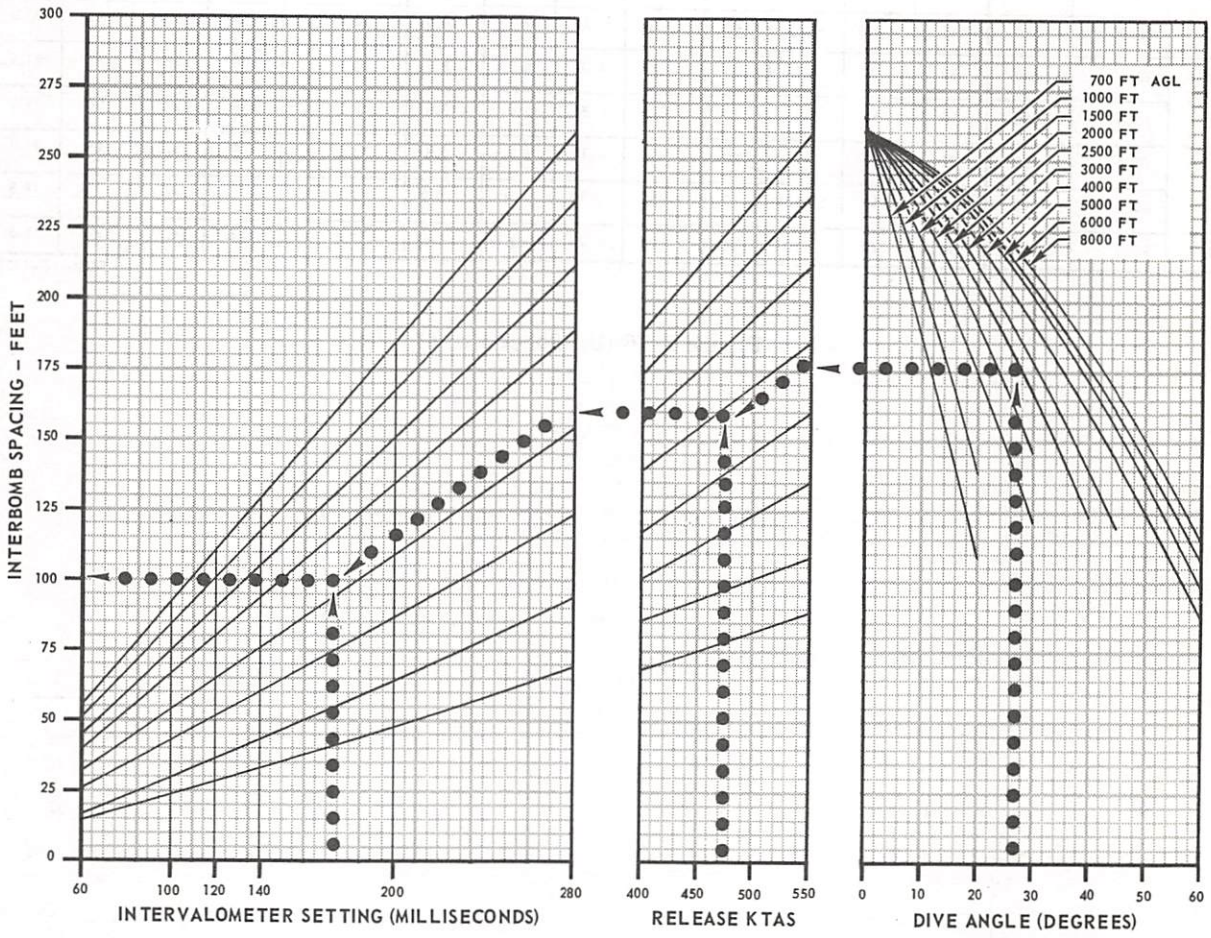
BOMB SPACING

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-RETARDED

Note

USE RELEASE HEIGHT AND RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE, MER-TER EJECTION VELOCITY 5.6 FT/SEC)



UNCLASSIFIED

FDB-1T-(170-10)

Figure 2-75 (U) (Sheet 9 of 9)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-UNRETARDED

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	1500	450	148	-149	-240	230	271	-358	32.7	-34.3	7.1	164	4.9	164	23.1
20°	2000	450	37	-38	-40	40	36	- 42	9.8	-10.0	4.4	98	9.9	97	22.0
30°	3000	450	32	-33	- 30	20	27	- 30	8.3	- 8.4	5.0	108	12.9	107	21.5
	5000	500	52	- 54	-30	30	51	- 56	12.9	-13.0	8.0	155	12.0	154	19.3
45°	4000	450	21	- 22	-10	10	18	- 19	6.7	- 6.8	5.2	109	16.2	109	21.0
	6000	500	31	- 32	-10	10	30	- 32	9.8	-9.9	7.7	145	14.7	145	18.8
60°	7000	500	19	- 20	-10	10	23	- 24	8.6	- 8.6	7.8	144	16.7	144	18.5

FDB-1T-(171-1)

UNCLASSIFIED

Figure 2-76 (U) (Sheet 1 of 6)

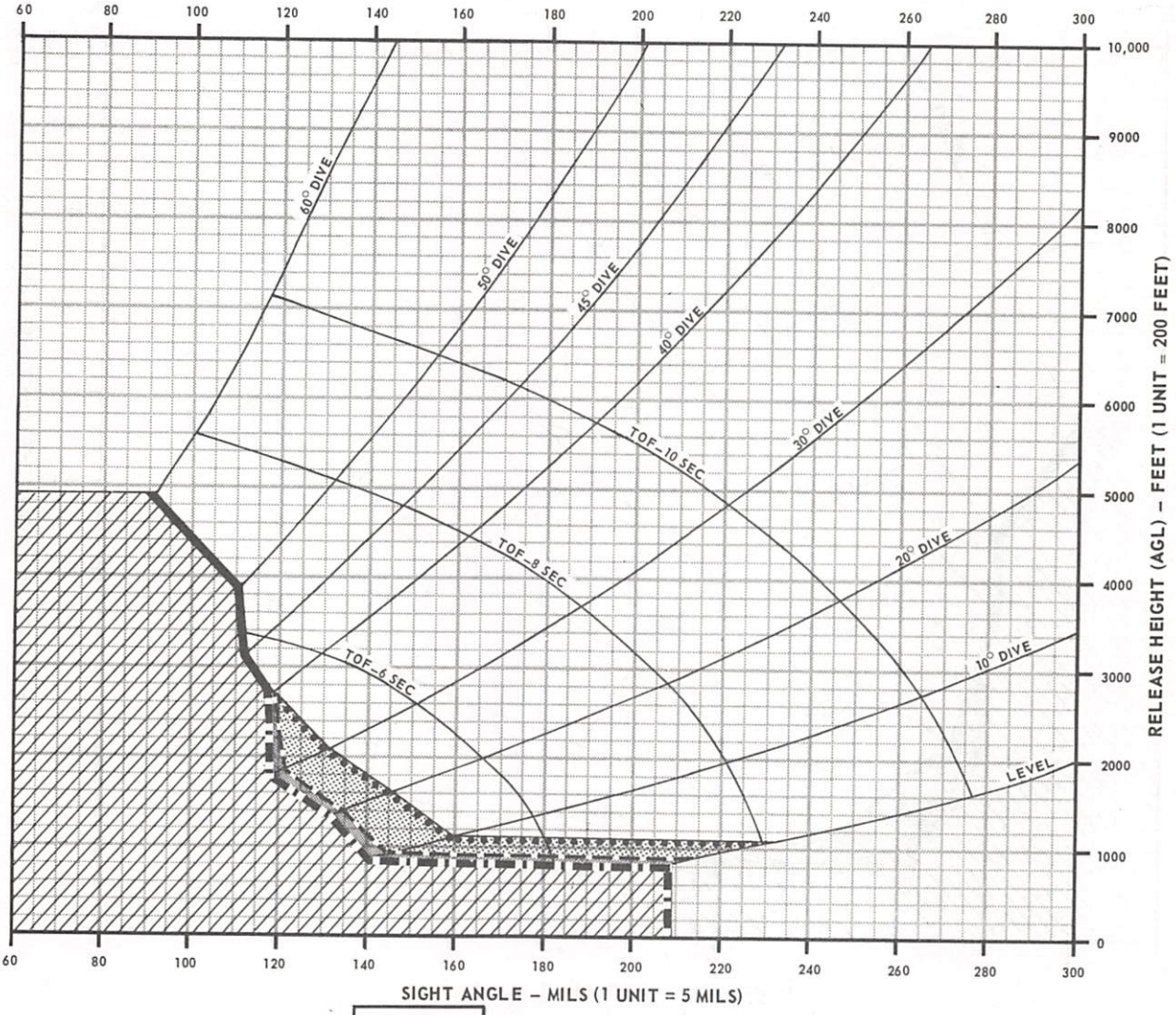
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-UNRETARDED

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1100	232	1100	900	214	900	850	209	850
10	1100	160	825	925	145	625	875	141	600
20	1600	146	900	1400	135	700	1375	133	675
30	2100	131	825	1850	121	575	1800	119	525
FRAG / TERRAIN 40	2725	118	700	2725	118	700	2725	118	700
45	3150	113	700	3150	113	700	3150	113	700
50	3925	111	1000	3925	111	1000	3925	111	1000
60	4950	91	1000	4950	91	1000	4950	91	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 531 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.0 HIT PROBABILITY
0.001 HIT PROBABILITY
0.01 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(171-2)

Figure 2-76 (U) (Sheet 2 of 6)

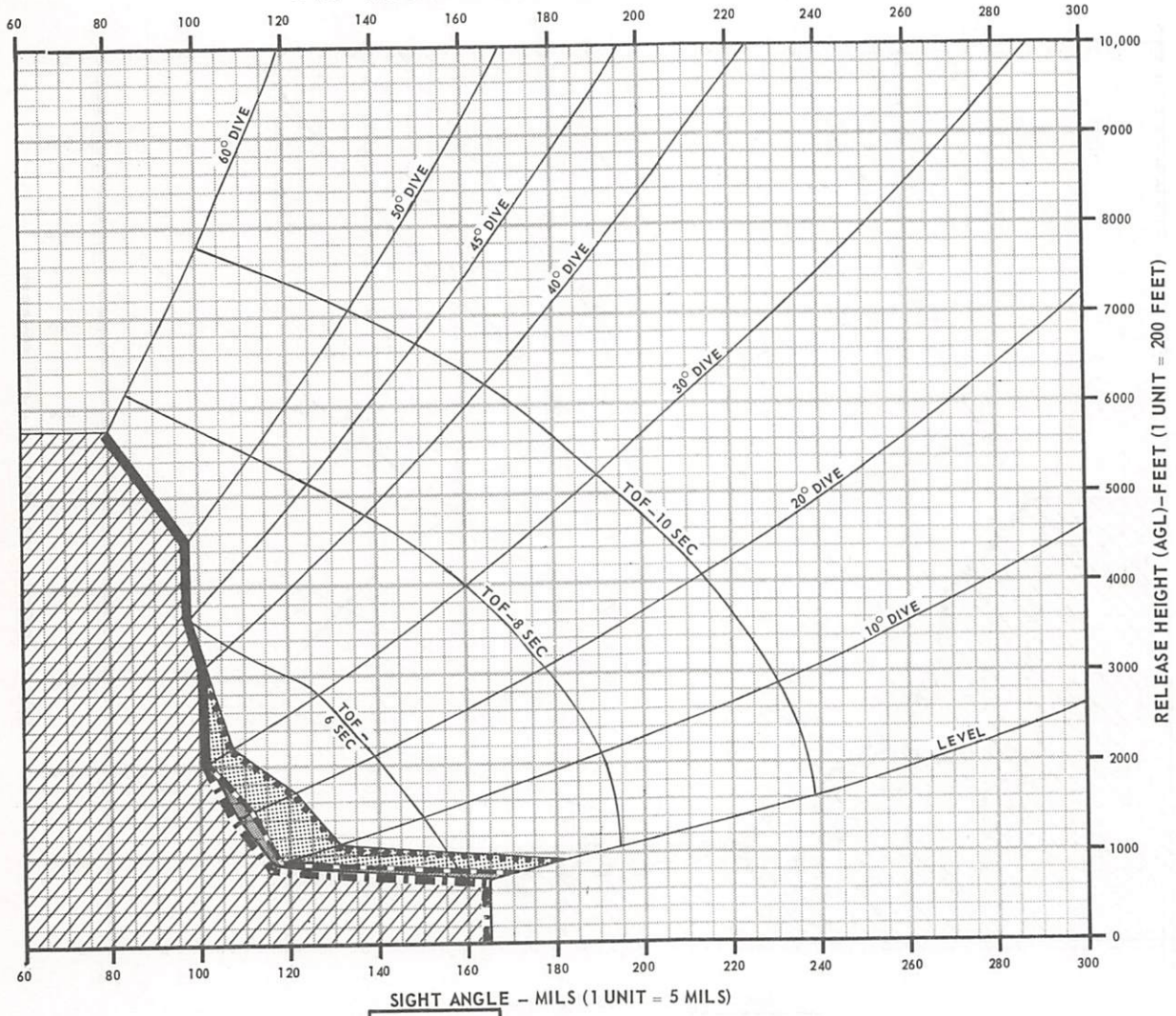
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-UNRETARDED

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	900	183	900	800	173	800	725	165	725
10	1100	131	775	925	118	600	900	116	575
20	1700	121	875	1500	112	675	1425	108	600
30	2200	107	675	2025	102	500	2025	102	500
40	3125	102	700	3125	102	700	3125	102	700
45	3650	98	700	3650	98	700	3650	98	700
50	4525	97	1000	4525	97	1000	4525	97	1000
60	5750	80	1000	5750	80	1000	5750	80	1000

FRAG

TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 531 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.0 HIT PROBABILITY
0.001 HIT PROBABILITY
0.01 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB–1T–(171–3)

NEW NEW NEW

Figure 2-76 (U) (Sheet 3 of 6)

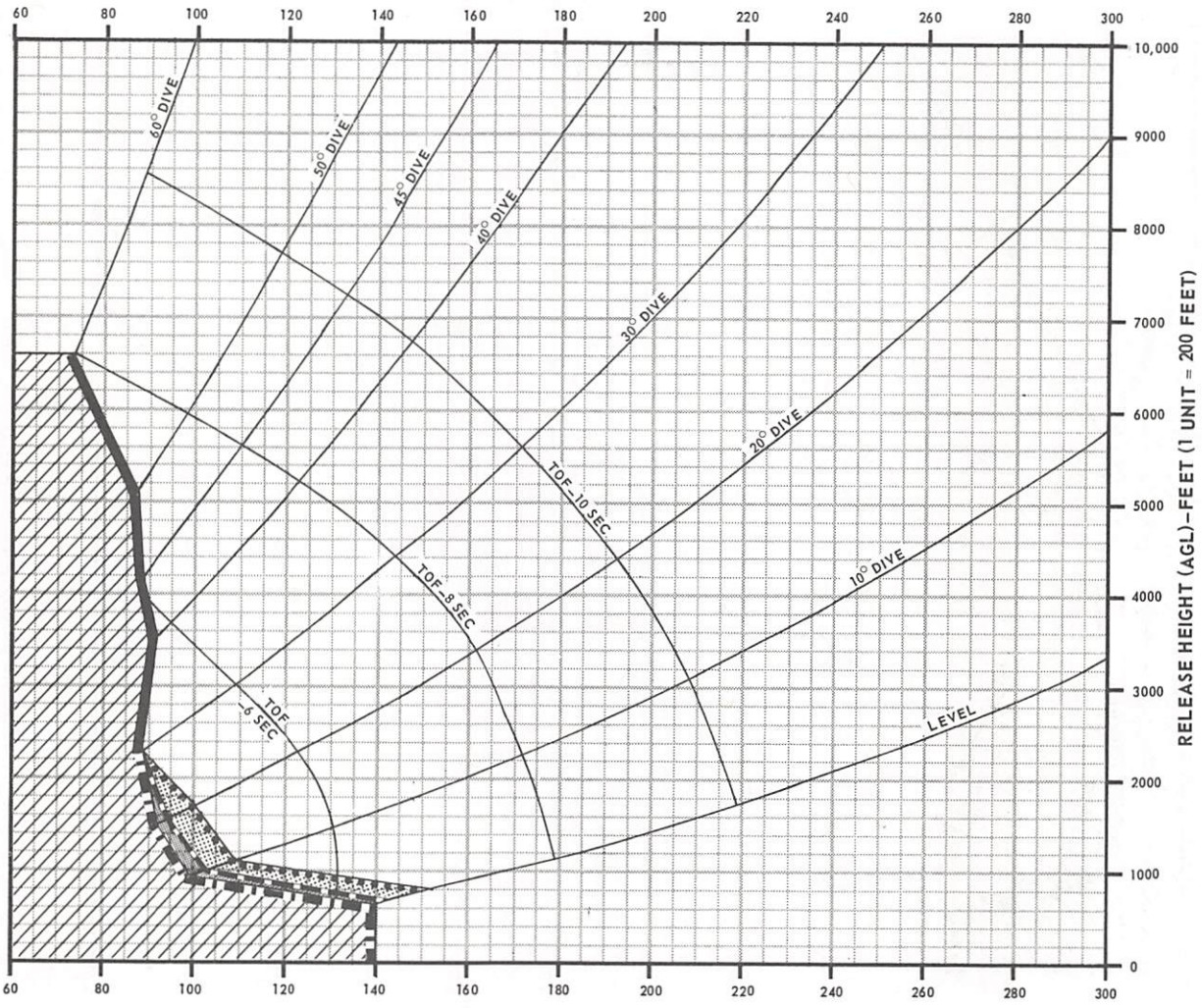
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-UNRETARDED

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	800	152	800	700	143	700	675	140	675
10	1100	109	750	1000	103	650	950	99	660
20	1700	100	750	1575	95	625	1500	92	550
FRAG / TERRAIN 30	2300	89	500	2300	89	500	2300	89	500
40	3550	92	700	3550	92	700	3550	92	700
45	4175	89	700	4175	89	700	4175	89	700
50	5125	87	1000	5125	87	1000	5125	87	1000
60	6600	73	1000	6600	73	1000	6600	73	1000

NEW NEW NEW

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 531 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.0 HIT PROBABILITY
0.001 HIT PROBABILITY
0.01 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(171-4)

Figure 2-76 (U) (Sheet 4 of 6)

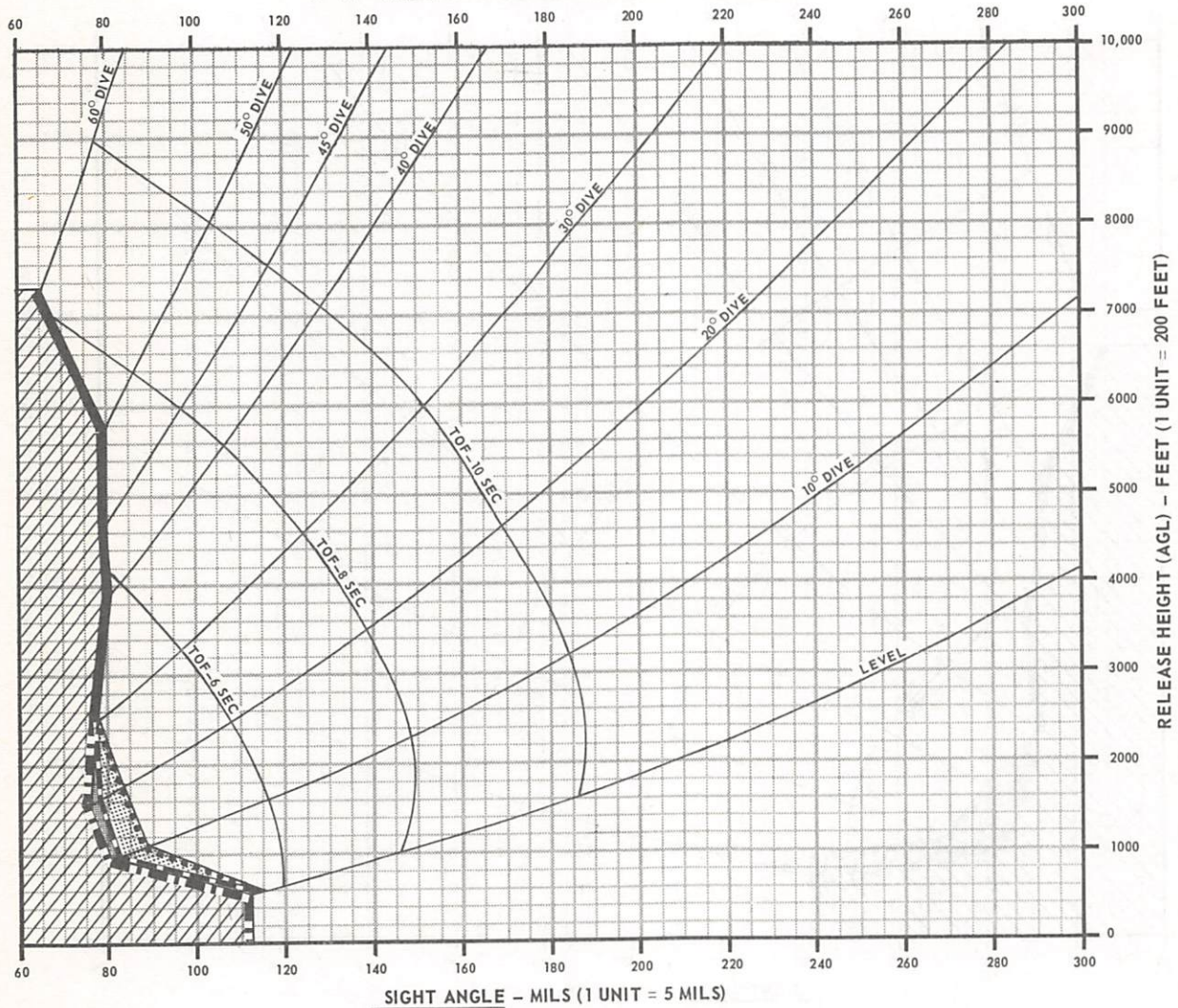
SIGHT ANGLE

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-UNRETARDED

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 5.6 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	600	115	600	600	115	600	575	113	575
10	1100	89	700	1000	83	600	975	81	575
20	1800	84	700	1625	78	525	1575	76	475
FRAG / TERRAIN 30	2550	79	500	2550	79	500	2550	79	500
40	3975	81	700	3975	81	700	3975	81	700
45	4675	80	700	4675	80	700	4675	80	700
50	5725	80	1000	5725	80	1000	5725	80	1000
60	7350	66	1000	7350	66	1000	7350	66	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY
*MK 82 SNAKEYE: 570 LBS/5.6 FPS
MK 36 DESTRUCTOR: 531 LBS/5.6 FPS
MK 124 PRACTICE: 565 LBS/5.6 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.0 HIT PROBABILITY
0.001 HIT PROBABILITY
0.01 HIT PROBABILITY
TERRAIN AVOIDANCE

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(171-5)

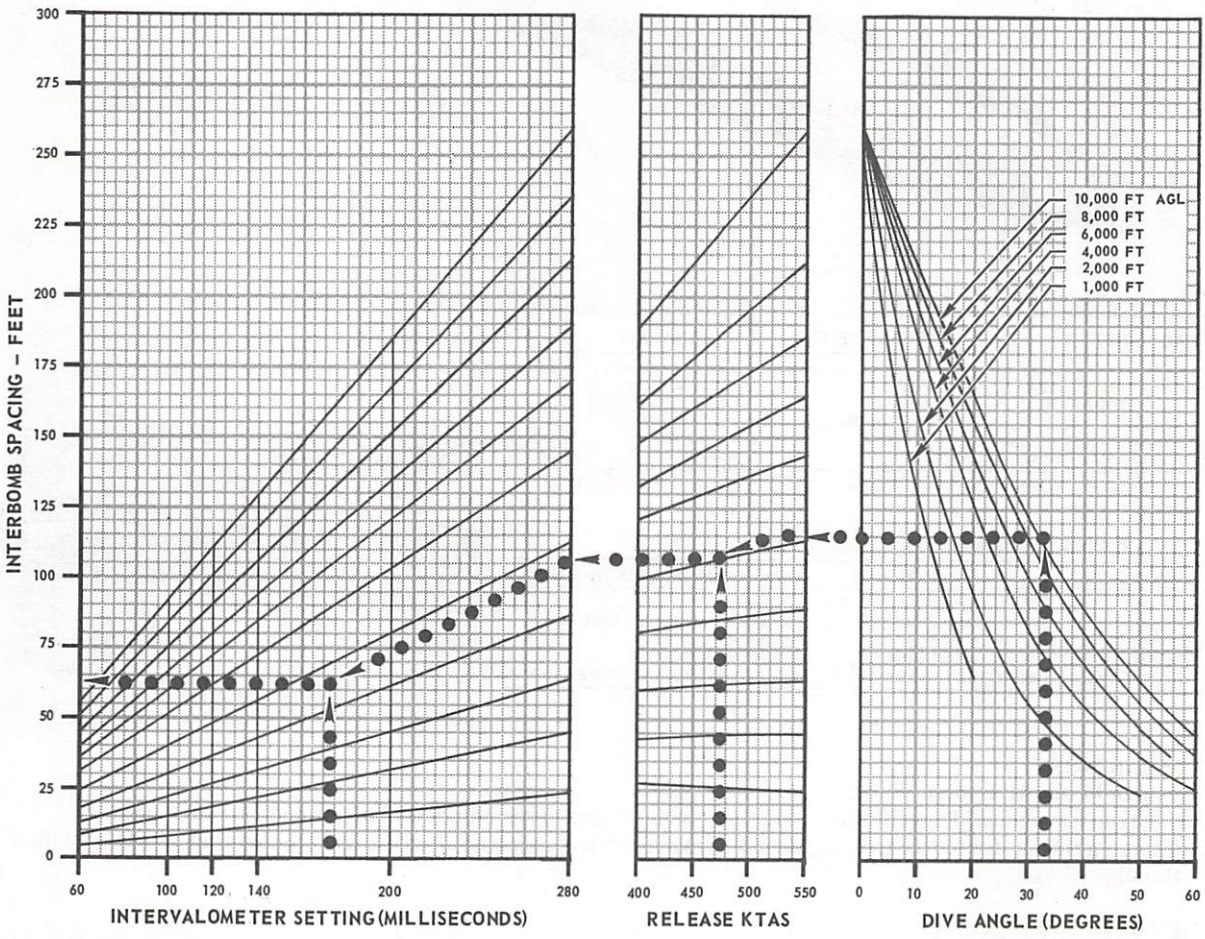
Figure 2-76 (U) (Sheet 5 of 6)

BOMB SPACING

MK 82 SNAKEYE, MK 36 DESTRUCTOR AND MK 124 PRACTICE-UNRETARDED

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB
(BASED ON SIX BOMB RIPPLE RELEASE,
MER–TER EJECTION VELOCITY 5.6 FT/SEC)



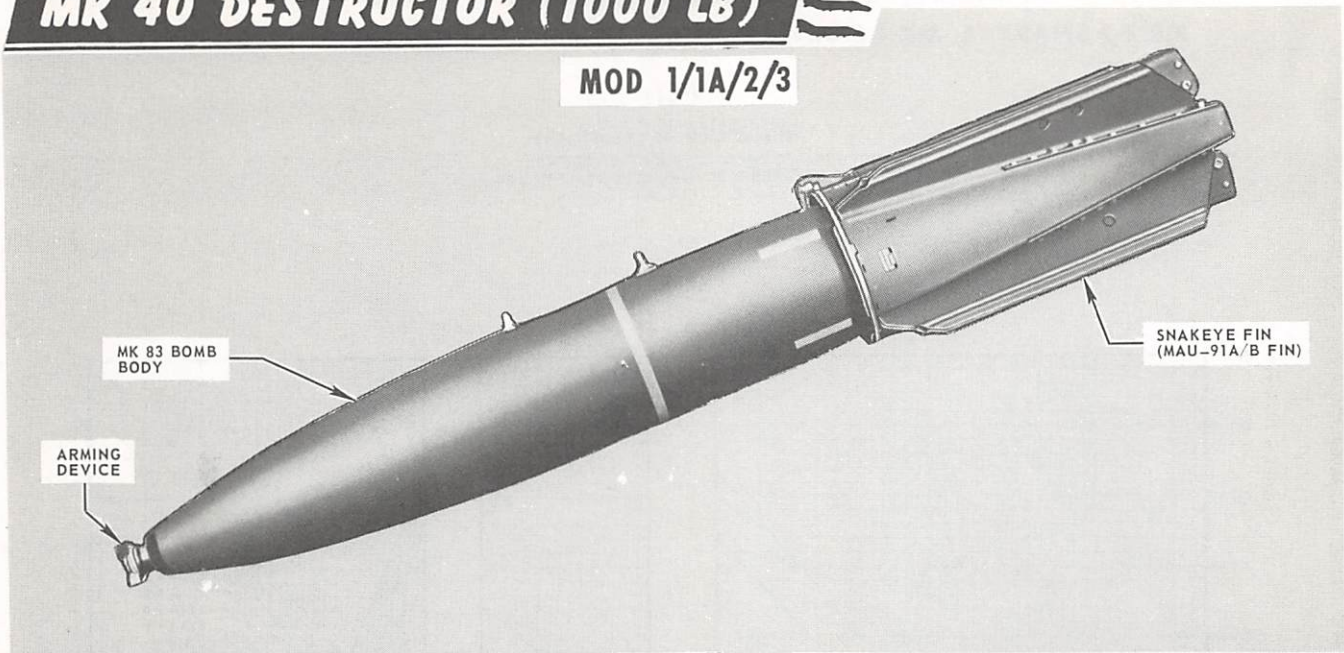
UNCLASSIFIED

FDB–1T–(171–6)

Figure 2-76 (U) (Sheet 6 of 6)

MK 40 DESTRUCTOR (1000 LB)

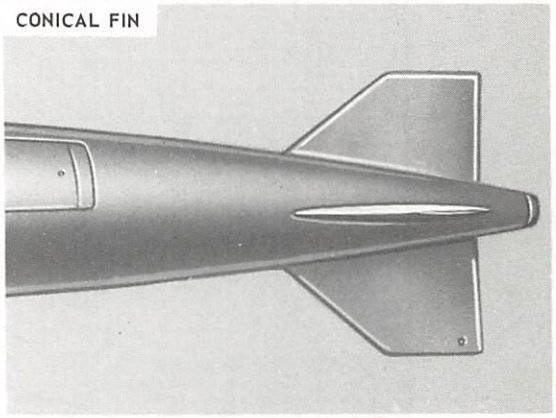
MOD 1/1A/2/3



CHARACTERISTICS:	SNAKEYE FIN	CONICAL FIN
LENGTH	9 FEET, 5.5 INCHES	9 FT, 11 INCHES
DIAMETER (FINS CLOSED)	22.8 INCHES	19.6 INCHES
(FINS OPEN)	83.5 INCHES	NOT APPLICABLE
WEIGHT	1057 POUNDS	985 POUNDS
SUSPENSION	14 INCHES	14 INCHES
TOP OF FRAG PATTERN	2820 FEET	2820 FEET

NEW

CONICAL FIN



COMPONENTS OF COMPLETE WEAPON

	MK 40 MOD 1	MK 40 MOD 1A/2/3
BOMB BODY	MK 83	MK 83
FIN ASSEMBLY	MAU-91A/B	MAU-91A/B OR CONICAL
ARMING DEVICE	MK 30	MK 32
FIRING MECHANISM	MK 42 MOD 1	MK 42 MOD 1/2/3
AUTHORIZED DELIVERY MODES	RETARDED ONLY	RETARDED AND UNRETARDED

PAINT/MARKINGS

Yellow bands on olive drab body.
White stripe around mid-section and four six inch stripes spaced around after end of bomb casing.
Mk 30 nose arming device is green; Mk 32 arming device is gold. Tail firing mechanism is black with a gold flange.

DESCRIPTION

The Mk 40 Destructor consists of a Mk 83 bomb fitted with a nose arming device and a tail firing mechanism that allows the weapon to function as a magnetic influence weapon for use against shallow water and land targets. The Destructor Modification Kit Mk 75 provides the special arming and firing mechanisms. See Fuzing Section and NAVORD OP 3529 for details of these mechanisms. Delivery data and Sight settings are the same as for Mk 83 bomb in similar configuration.

REFERENCES

1. Bomb Assembly . . . . . NAVORD OP 3529
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations . . . . . Section II, Part I
4. Loading Procedures, Arming Wire Configuration and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's . . . . .
6. Stores Reliability Card. . . . . (CONICAL FIN) NAVAIR 01-245FD-75-2.2
   (SNAKEYE FIN) NAVAIR 01-245FD-75-3.3

CONFIDENTIAL

FDB-1T-(172-1)

Figure 2-77 (C) (Sheet 1 of 8)

MAXIMUM FRAGMENT ENVELOPE
MK 83 BOMB

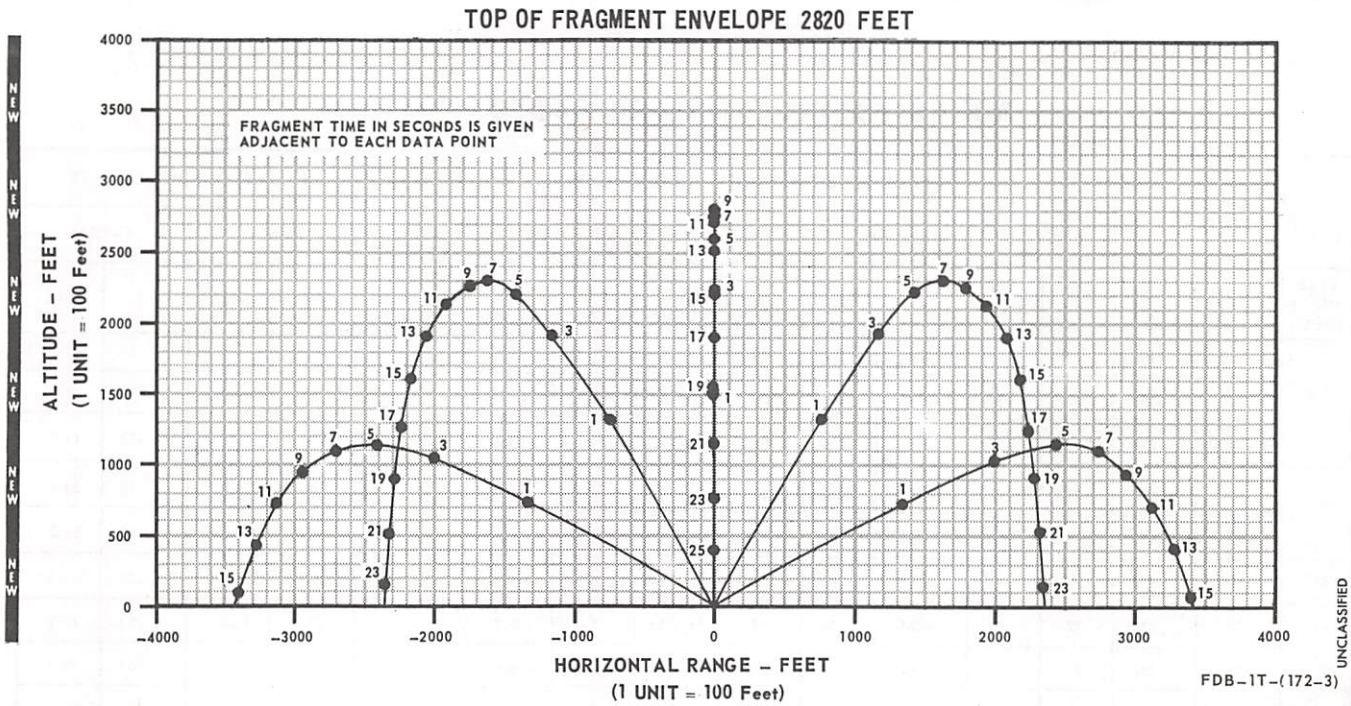


Figure 2-77 (U) (Sheet 2 of 8)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 40 DESTRUCTOR – RETARDED

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE (DEG)	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	100	450	27	–27	–1080	–	163	–396	21.7	–25.3	1.5	45	1.9	45	29.8
	300	450	33	–34	– 540	460	169	–253	16.7	–18.0	2.3	85	4.9	86	37.2
	500	450	36	–36	– 390	360	157	–207	14.2	–15.0	2.7	114	7.8	113	41.9
10°	600	450	21	–21	– 160	130	50	– 65	7.5	– 7.8	2.1	75	9.8	73	34.9
	800	450	25	–26	– 160	140	63	– 77	7.8	– 8.1	2.5	97	12.2	96	38.5
20°	1500	450	23	–24	– 90	80	43	– 49	5.8	– 5.9	3.0	122	20.9	124	41.3
30°	3000	450	27	–27	– 60	60	49	– 53	5.8	– 5.9	4.2	201	34.4	201	47.9
	4000	450	31	–31	– 60	50	64	– 68	6.6	– 6.6	5.1	269	40.7	267	52.3
	5000	450	33	–34	– 50	50	78	– 81	7.4	– 7.4	6.1	335	45.3	336	55.1
	6000	450	35	–36	– 50	50	91	– 95	8.1	– 8.2	7.0	397	48.7	398	56.9
45°	4000	450	21	–22	– 40	40	40	– 42	5.5	– 5.5	4.7	224	40.7	224	47.7
	6000	450	27	–27	– 30	30	69	– 71	7.3	– 7.3	6.6	351	48.1	350	53.0
	8000	450	30	–30	– 30	30	98	–101	9.1	– 9.2	8.5	475	51.9	472	55.5
60°	6000	450	18	–18	– 20	20	52	– 54	6.6	– 6.6	6.3	317	48.0	317	50.3
	8000	450	20	–21	– 20	20	82	– 83	8.5	– 8.5	8.3	438	51.5	442	53.2
	10000	450	22	–22	– 20	20	112	–114	10.5	–10.5	10.2	560	53.3	556	54.5

UNCLASSIFIED

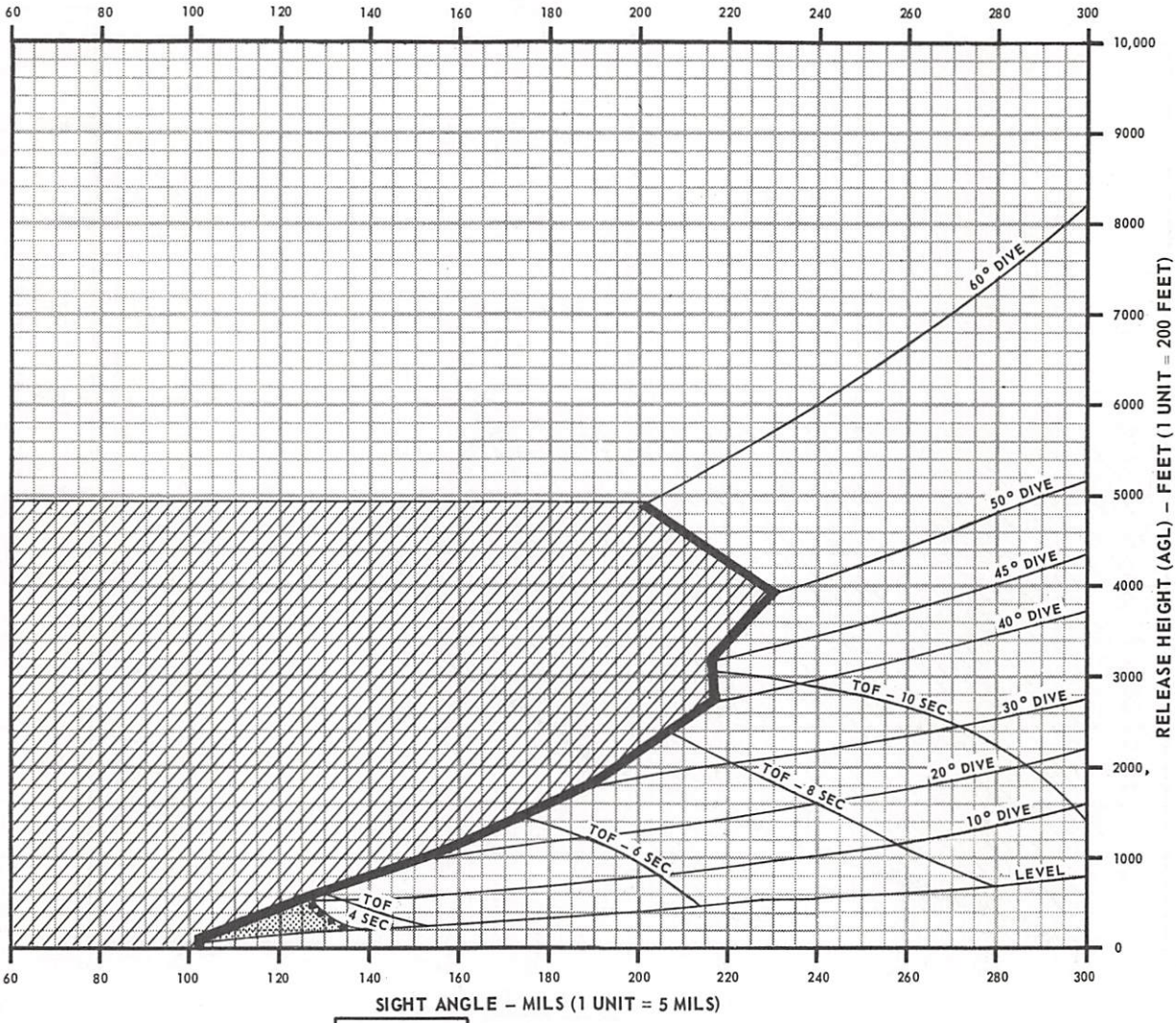
FDB-1T-(172-2)

Figure 2-77 (U) (Sheet 3 of 8)

SIGHT ANGLE
MK 40 DESTRUCTOR-RETARDED
400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

NEW NEW NEW

	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL									
	DIVE ANGLE (DEG)	0.000			0.001			0.010		
		MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
FRAG	0	200	139	200	100	103	100	100	103	100
TERRAIN	10	475	127	200	475	127	200	475	127	200
	20	1000	155	300	1000	155	300	1000	155	300
	30	1775	192	500	1775	192	500	1775	192	500
	40	2725	218	700	2725	218	700	2725	218	700
	45	3150	217	700	3150	217	700	3150	217	700
	50	3925	231	1000	3925	231	1000	3925	231	1000
	60	4950	202	1000	4950	202	1000	4950	202	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 40 DESTRUCTOR: 1057 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(172-4)

Figure 2-77 (U) (Sheet 4 of 8)

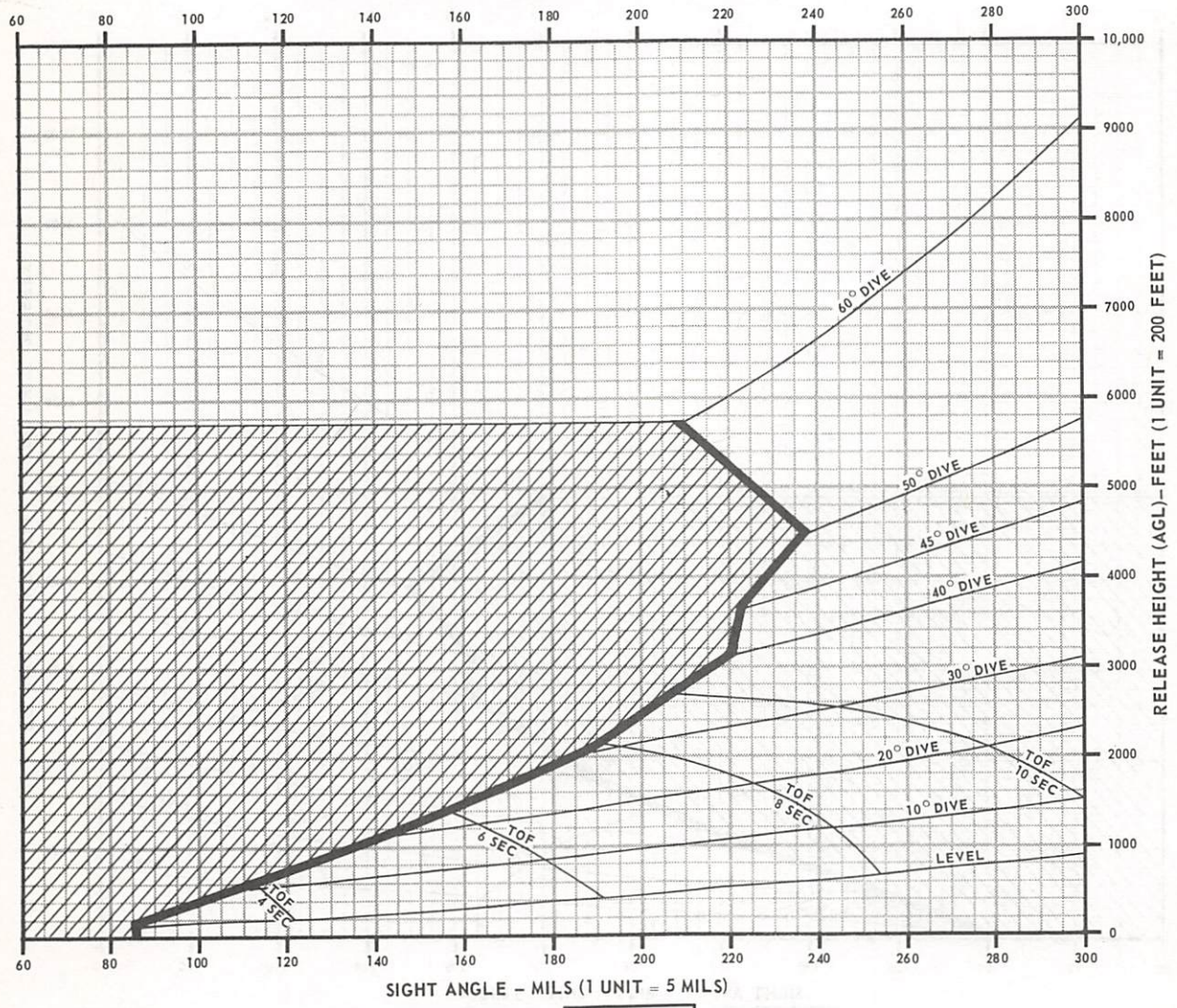
SIGHT ANGLE

MK 40 DESTRUCTOR-RETARDED

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	Height in Feet AGL		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	100	86	100
10	525	113	200
20	1125	145	300
30	2025	189	500
40	3125	221	700
45	3650	223	700
50	4525	239	1000
60	5750	210	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 40 DESTRUCTOR: 1057 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(172-5)

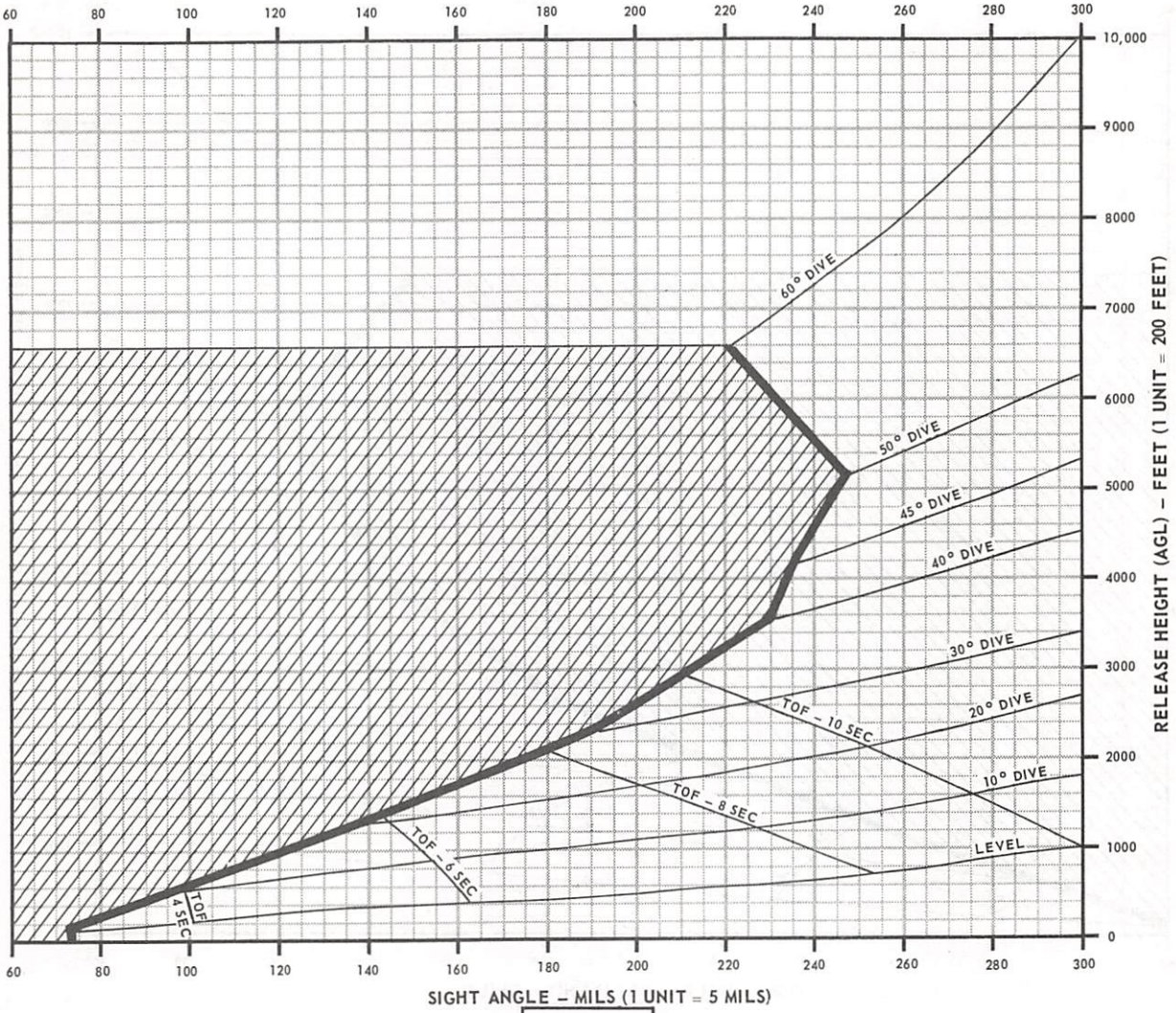
NEW NEW NEW

Figure 2-77 (U) (Sheet 5 of 8)

SIGHT ANGLE
MK 40 DESTRUCTOR-RETARDED
500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	Height in feet AGL		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	100	74	100
10	550	99	200
20	1250	140	300
30	2300	192	500
40	3550	231	700
45	4175	236	700
50	5125	248	1000
60	6600	222	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 40 DESTRUCTOR: 1057 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(172-6)

NEW NEW NEW

Figure 2-77 (U) (Sheet 6 of 8)

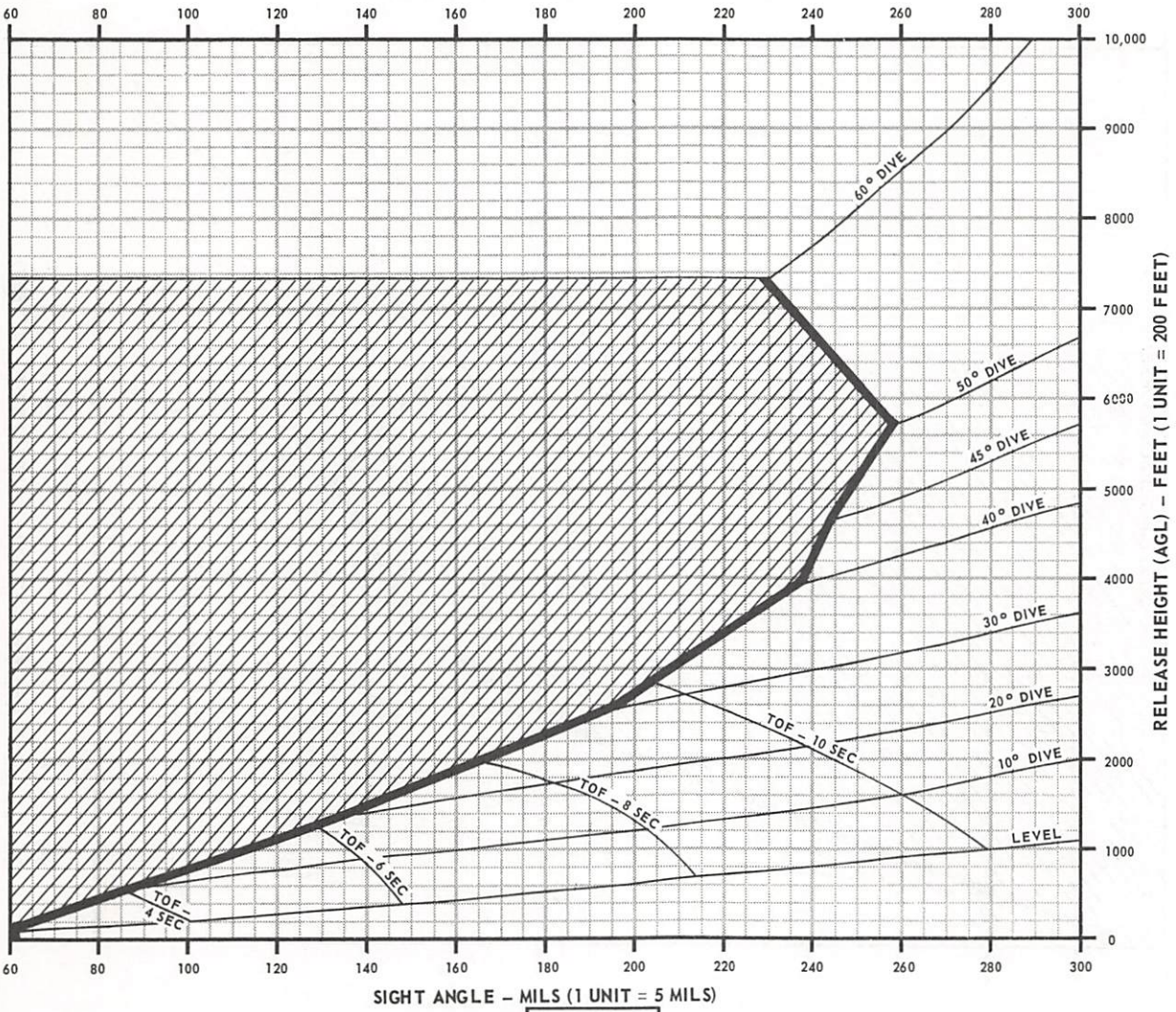
SIGHT ANGLE

MK 40 DESTRUCTOR-RETARDED

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	Height in Feet AGL		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	100	62	100
10	600	91	200
20	1400	138	300
30	2550	196	500
40	3975	239	700
45	4675	245	700
50	5725	259	1000
60	7350	230	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 40 DESTRUCTOR: 1057 LBS/4.2 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(172-7)

NEW NEW NEW

Figure 2-77 (U) (Sheet 7 of 8)

BOMB SPACING
MK 40 DESTRUCTOR-RETARDED

NOTE
USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB
(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 4.2 FT/SEC)

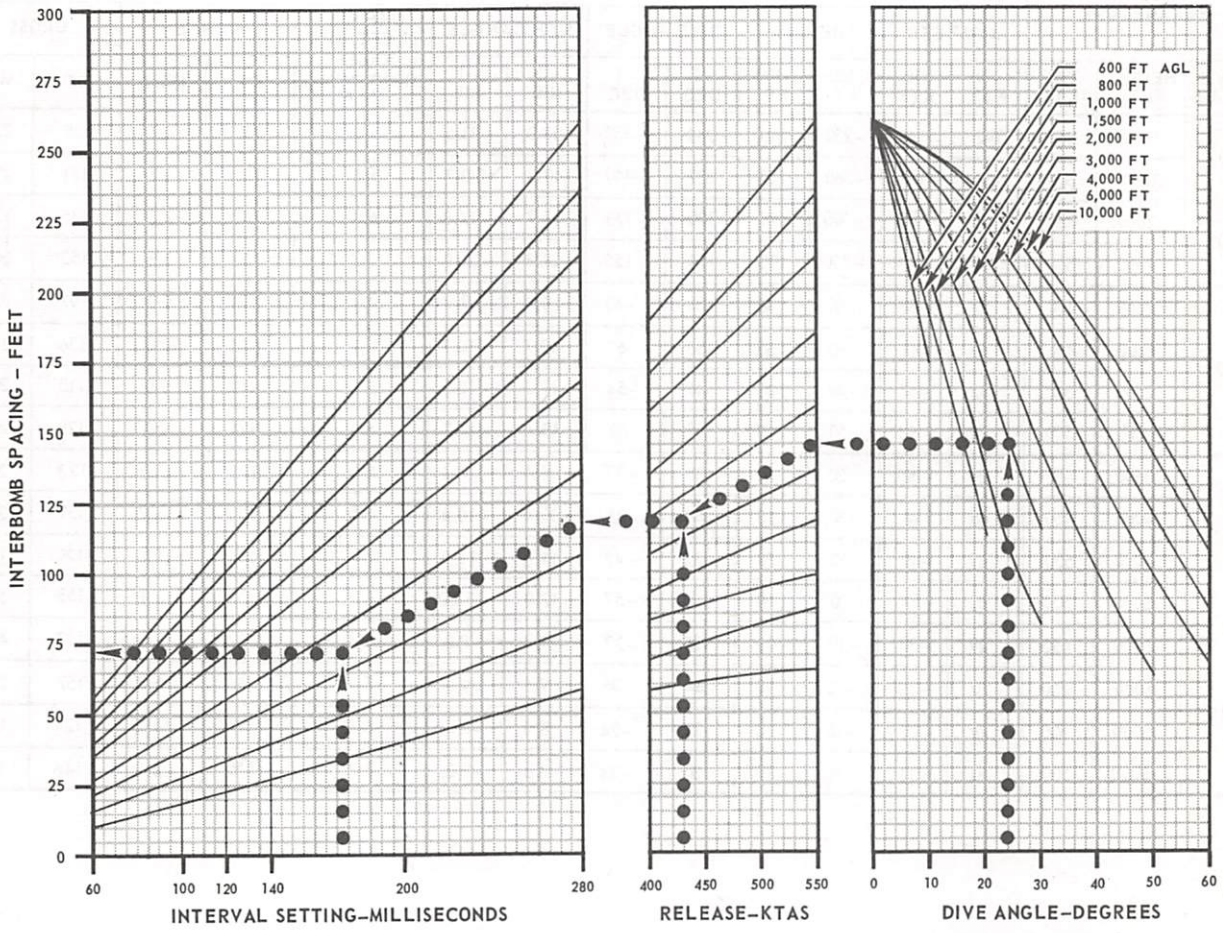


Figure 2-77 (U) (Sheet 8 of 8)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 40 DESTRUCTOR-UNRETARDED

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND –10 KNOTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT (SLANT RANGE –1000 FT)	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL		FT	MILS	FT	MILS
0°	1400	450	142	–143	–250	240	269	–359	33.2	–33.5	6.8	157	4.7	158	23.2
	1600	500	150	–151	–260	250	327	–440	40.3	–40.7	8.1	170	4.2	171	21.1
10°	2000	450	81	–82	–100	90	100	–123	17.7	–17.8	6.0	133	7.5	135	22.5
	2500	500	90	–92	–100	100	126	–155	21.8	–21.9	7.4	151	6.9	152	20.5
20°	2000	450	37	–38	–40	40	36	–43	9.9	–9.9	4.4	98	9.9	97	22.0
	3000	450	59	–61	–50	50	58	–67	12.7	–12.7	6.2	135	10.6	136	21.9
	2500	500	42	–43	–40	40	46	–54	12.2	–12.3	5.5	110	9.0	110	20.0
	3000	500	52	–53	–50	40	57	–66	13.7	–13.8	6.4	128	9.3	128	20.0
30°	3500	450	39	–40	–30	30	33	–37	9.4	–9.4	5.7	123	13.1	123	21.5
	4000	450	46	–48	–30	30	40	–45	10.4	–10.4	6.5	137	13.2	139	21.4
	4000	500	39	–40	–30	30	38	–42	11.0	–11.0	6.6	130	11.8	129	19.6
	5000	500	52	–54	–30	30	51	–57	12.9	–13.0	8.0	157	12.1	155	19.4
45°	5000	450	29	–30	–10	10	25	–27	8.2	–8.2	6.4	134	16.3	133	20.8
	6000	450	37	–38	–10	10	34	–36	9.6	–9.6	7.6	156	16.3	157	20.6
	5000	500	24	–25	–10	10	23	–24	8.4	–8.4	6.5	123	14.7	124	19.1
	6000	500	31	–32	–10	10	30	–33	9.8	–9.8	7.7	145	14.8	146	18.9

UNCLASSIFIED

FDB-1T-(223-1)

Figure 2-78 (U) (Sheet 1 of 6)

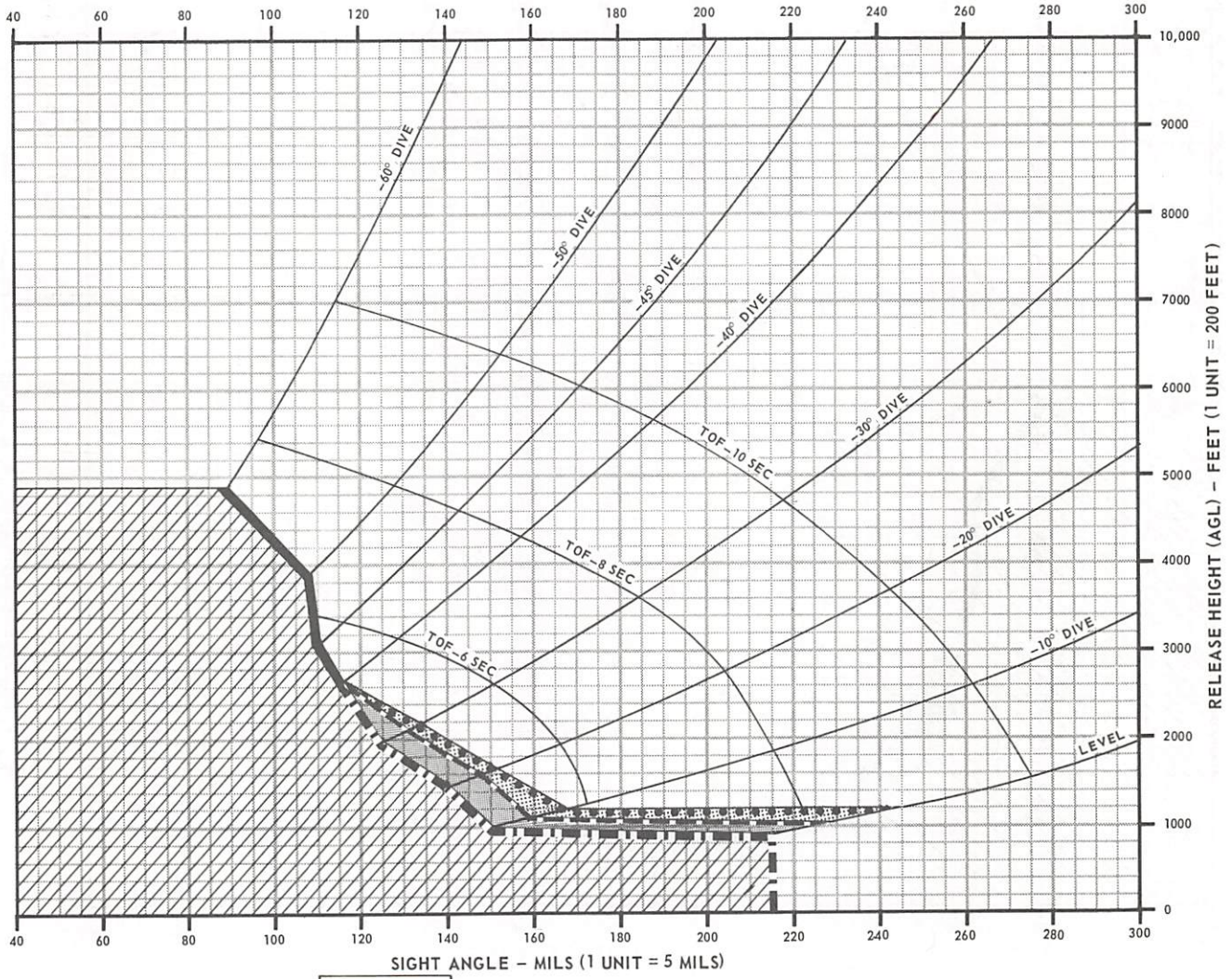
SIGHT ANGLE

MK 40 DESTRUCTOR-UNRETARDED

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1200	242	1200	1075	229	1075	925	216	925
10	1200	168	925	1100	159	825	1000	151	725
20	1700	151	1000	1650	147	950	1525	140	825
FRAG 30	2200	134	925	2150	132	875	2000	125	725
TERRAIN 40	2725	116	700	2725	116	700	2725	116	700
45	3150	111	700	3150	111	700	3150	111	700
50	3925	109	1000	3925	109	1000	3925	109	1000
60	4950	89	1000	4950	89	1000	4950	89	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(223-3)

Figure 2-78 (U) (Sheet 2 of 6)

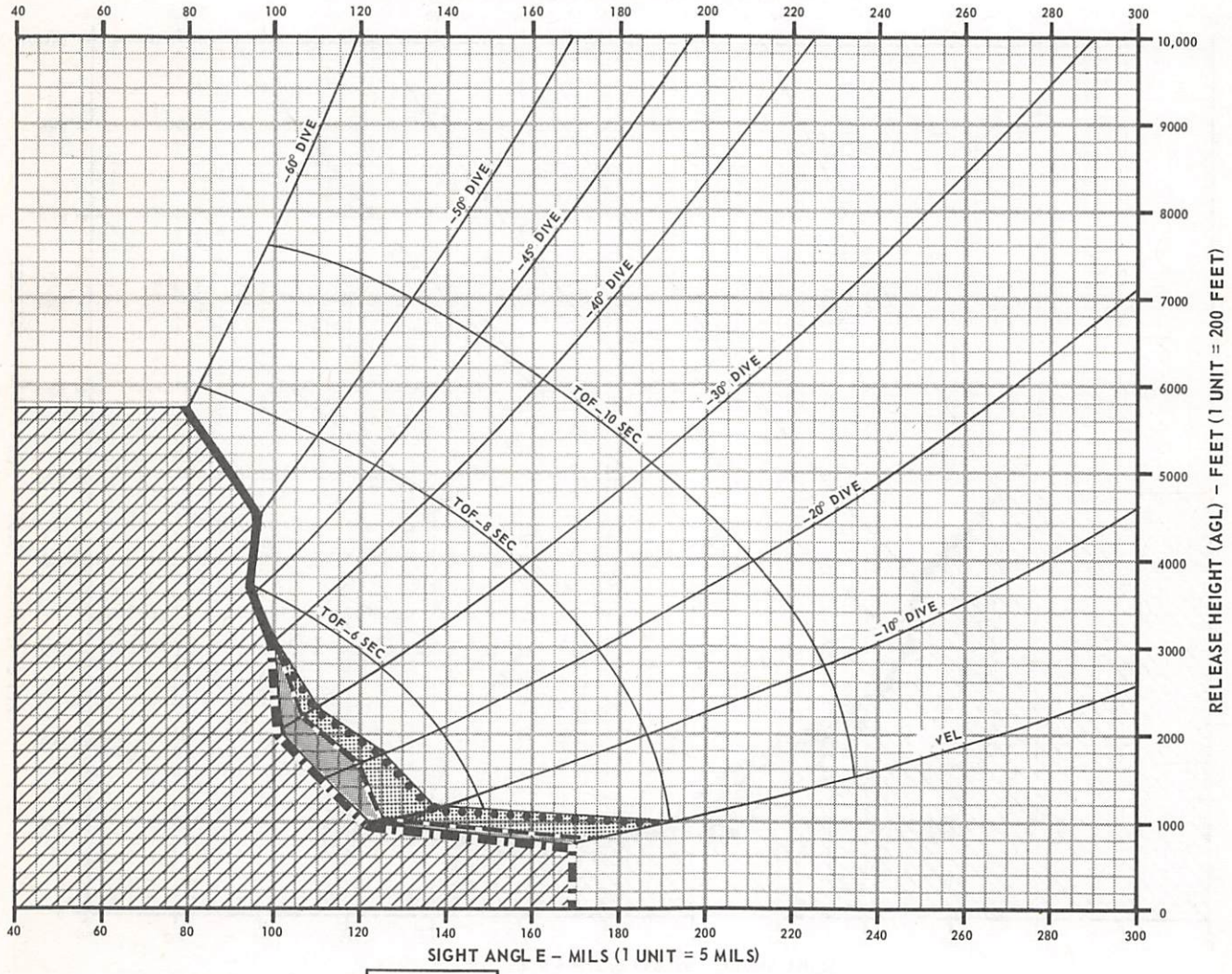
SIGHT ANGLE

MK 40 DESTRUCTOR -UNRETARDED

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS)



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1000	192	1000	825	175	825	775	170	775
10	1200	137	875	1025	124	700	1000	122	675
20	1800	125	975	1675	119	850	1550	113	725
30	2300	109	775	2225	107	700	2075	102	550
40	3125	100	700	3125	100	700	3125	100	700
45	3650	96	700	3650	96	700	3650	96	700
50	4525	96	1000	4525	96	1000	4525	96	1000
60	5750	79	1000	5750	79	1000	5750	79	1000

FRAG

TERRAIN

NEW NEW NEW

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(223-4)

Figure 2-78 (U) (Sheet 3 of 6)

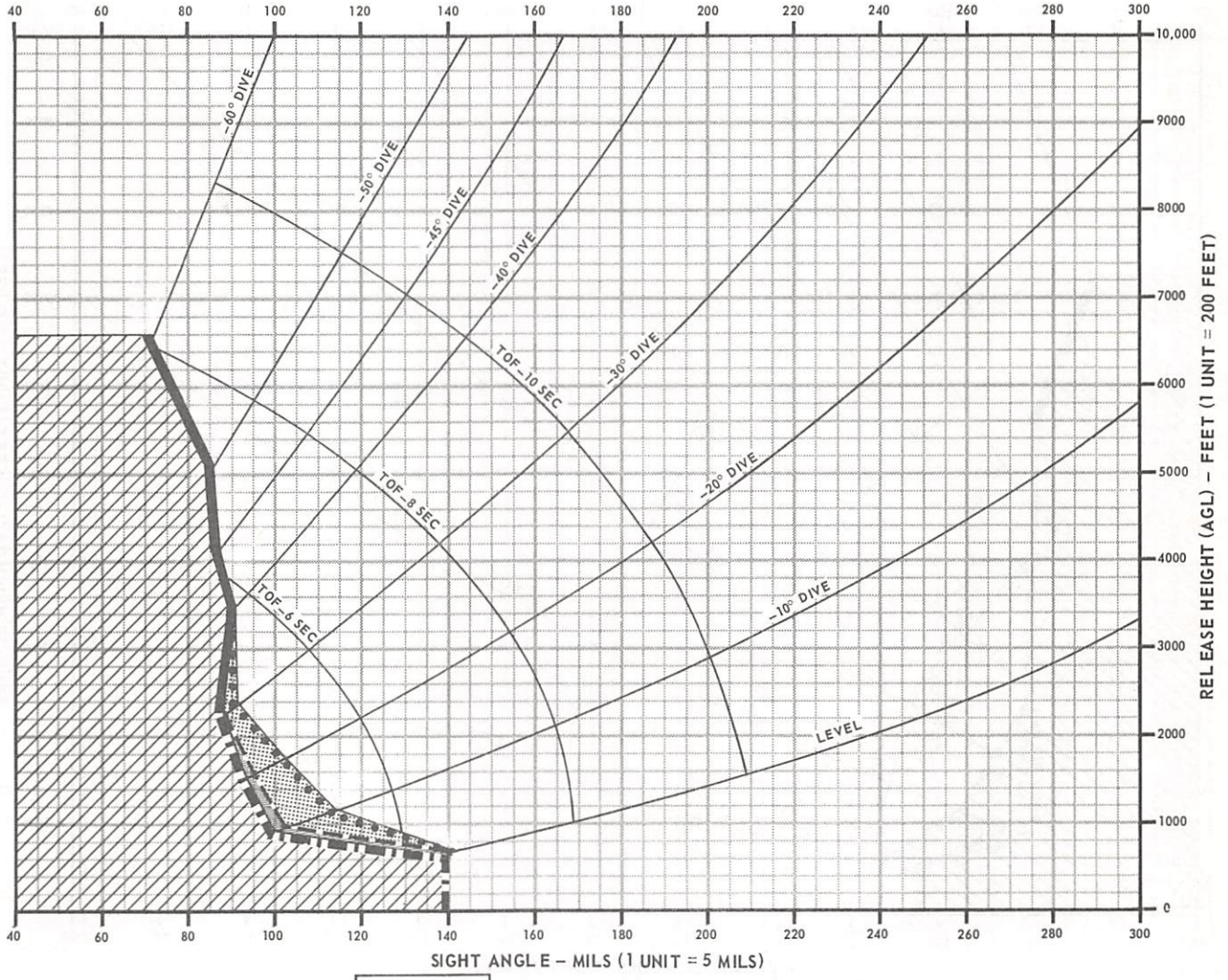
SIGHT ANGLE

MK 40 DESTRUCTOR-UNRETARDED

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	700	142	700	700	142	700	675	140	675
10	1200	114	850	1000	102	650	975	100	625
20	1800	102	850	1600	95	650	1575	94	625
FRAG 30	2400	91	600	2300	88	500	2300	88	500
TERRAIN 40	3550	91	700	3550	91	700	3550	91	700
45	4175	88	700	4175	88	700	4175	88	700
50	5125	86	1000	5125	86	1000	5125	86	1000
60	6600	72	1000	6600	72	1000	6600	72	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(223-5)

Figure 2-78 (U) (Sheet 4 of 6)

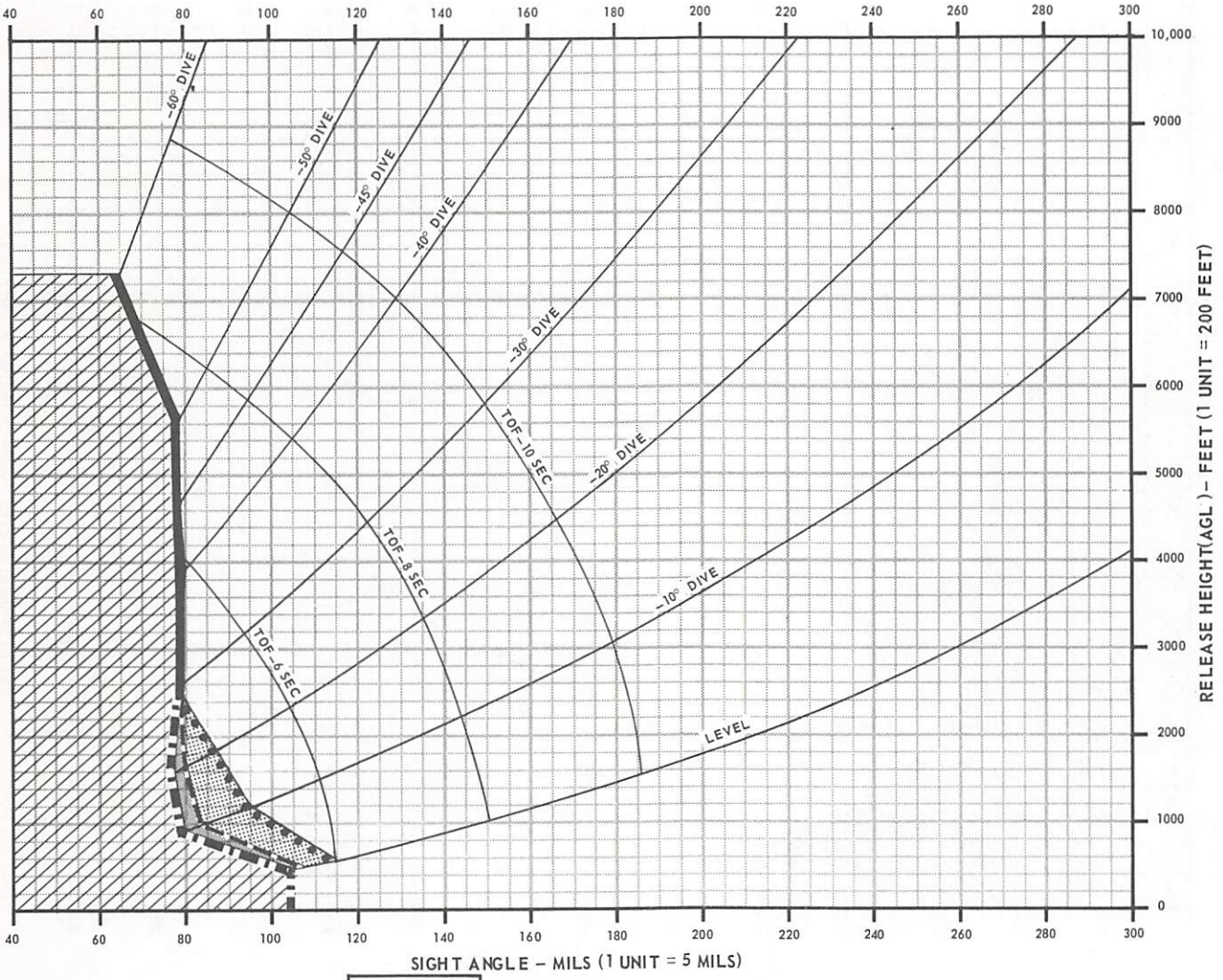
SIGHT ANGLE

MK 40 DESTRUCTOR-UNRETARDED

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS)



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	600	115	600	525	108	525	500	105	500
10	1200	94	800	1000	83	600	975	80	575
20	1900	87	800	1700	80	600	1625	77	525
FRAG / TERRAIN 30	2550	78	500	2550	78	500	2550	78	500
40	3975	80	700	3975	80	700	3975	80	700
45	4675	79	700	4675	79	700	4675	79	700
50	5725	79	1000	5725	79	1000	5725	79	1000
60	7350	65	1000	7350	65	1000	7350	65	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

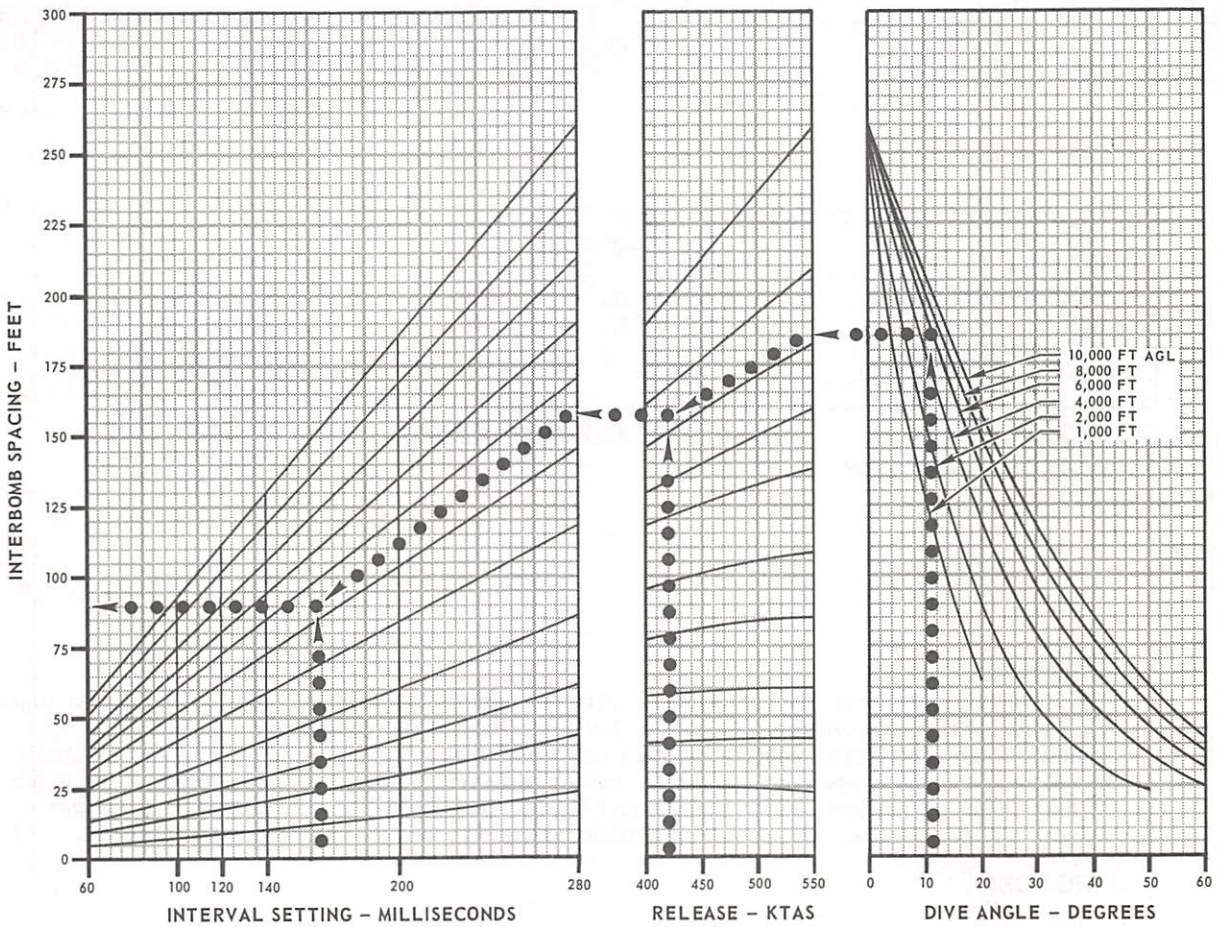
FDB-1T-(223-6)

Figure 2-78 (U) (Sheet 5 of 6)

BOMB SPACING
MK 40 DESTRUCTOR -UNRETARDED

NOTE

USE RELEASE HEIGHT AND RELEASE AIRSPEED OF LAST BOMB (BASED ON SIX BOMB RIPPLE RELEASE, MER-TER EJECTION VELOCITY 4.8 FT/SEC).

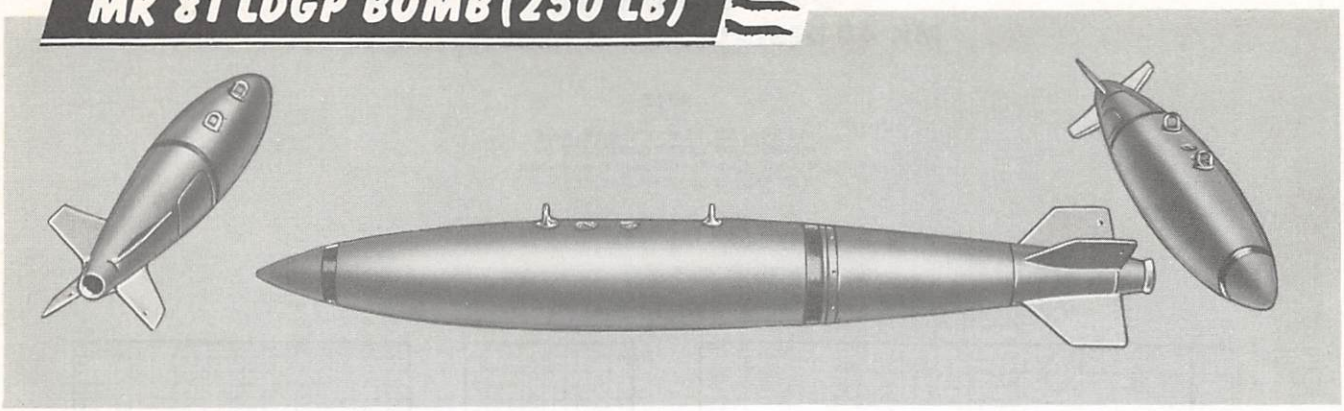


UNCLASSIFIED

FDB-1T-(223-7)

Figure 2-78 (U) (Sheet 6 of 6)

MK 81 LDGP BOMB (250 LB)

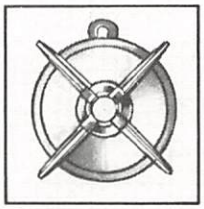


LENGTH	6 FEET 2 INCHES
DIAMETER	9 INCHES
EXPLOSIVE CHARGE	100 POUNDS
WEIGHT	270 POUNDS
SUSPENSION	14 INCHES
TOP OF FRAG PATTERN	2470 FEET

NEW

PAINTING AND MARKING
YELLOW BAND ON OLIVE DRAB BODY.

IDENTIFYING NOMENCLATURE IN YELLOW.



AFT VIEW

DESCRIPTION

The MK 81 is a low drag, general-purpose aircraft bomb with a slender body, long pointed nose and conical tail fin assembly. The assembled bomb weighs 260 pounds and is attached to the airplane bomb rack by two suspension lugs located 14 inches apart. A hoisting lug is located between the 14 inch suspension lugs at the center of gravity to provide for handling of the bomb. Primary kill mechanisms are fragments and blast. Weapon type is antimaterial and antipersonnel. Optional fuzing may be obtained by installing VT, mechanical or electrical fuzes.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-2.1

FDB-1T-(173-1) UNCLASSIFIED

Figure 2-79 (U) (Sheet 1 of 8)

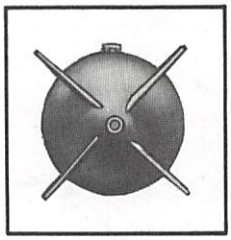
MK 86 PRACTICE BOMB (250 LB)

OD-93

CHARACTERISTICS:

LENGTH	6 FEET 4 INCHES
DIAMETER	9 INCHES
WEIGHT (LOADED)	
WET SAND	200 POUNDS
SUSPENSION	14 INCHES

PAINTING AND MARKING
IDENTIFYING NOMENCLATURE
STENCILED IN WHITE ON ORANGE
BODY.



AFT VIEW

DESCRIPTION

The MK 86 bomb is a 250 pound practice bomb. It is a low-drag bomb of the same size and shape as the MK 81 low-drag general purpose bombs. It has a streamlined nose and a conically tapered aft end. One filler hole is located on the side, aft of the cylindrical section. Four fin blades perpendicular to each other are located forward of the rear end of the bomb.

The 250 pound practice bomb MK 86 Mod 0 is of thin-case construction with internal reinforcement for the sway brace and ejection areas. To provide rigidity, bulkheads and channel reinforcements are used on the inside of the bomb shell.

Practice Bomb Signal MK 4 Mod 3 is used with 250 pound practice bomb MK 86 Mod 0. A blast tube extends from the nose to the aft end of the bomb and allows for exit of the signal smoke when fired. The firing pin assembly and signal are held in place inside the blast tube by a retaining cotter pin.

Double suspension lugs are spaced 14 inches apart on the body of the practice bomb MK 86 Mod 0. The lugs are of the screw-in type used with the low-drag general purpose bomb series. A screw-in type of hoisting lug is provided at the center of gravity of the bomb.

This bomb is filled with water or wet sand. Antifreeze is added to the filler during freezing conditions.

The practice bomb MK 86 Mod 1 is similar to the MK 86 Mod 0. The major differences between the two mods are that the Mod 1 uses an integrally welded suspension lug and a slightly different internal design. The delivery is prepared for MK 86 Mod 0 and Mod 1 practice bomb filled with wet sand.

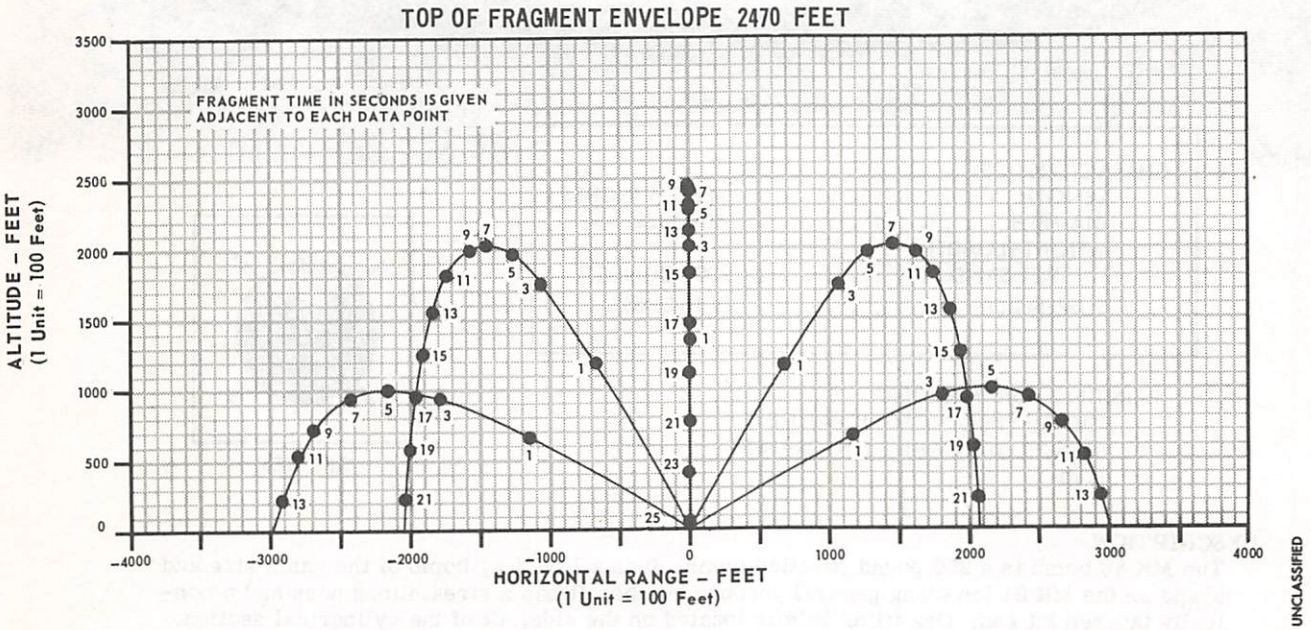
REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.

UNCLASSIFIED
FDB-1T-(173-2)

Figure 2-79 (U) (Sheet 2 of 8)

MAXIMUM FRAGMENT ENVELOPE
MK 81 BOMB



RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 81 LDGP AND MK 86 PRACTICE-CONICAL FIN

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT Slant Range 1000 Ft	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL		FT	MILS	FT	MILS
0°	1500	450	150	–151	–240	230	269	–357	33.1	–34.6	7.1	162	4.8	161	22.7
20°	2000	450	37	– 38	– 40	40	35	– 41	9.7	– 9.9	4.4	96	9.8	96	21.8
30°	3000	450	32	– 33	– 20	20	26	– 30	8.3	– 8.4	5.0	106	12.7	107	21.3
	5000	500	52	– 54	– 30	30	49	– 55	13.0	–13.0	8.1	153	11.8	154	19.0
45°	4000	450	21	– 22	– 10	10	17	– 19	6.7	– 6.7	5.2	107	16.0	108	20.8
	6000	500	31	– 32	– 10	10	29	– 32	9.8	– 9.9	7.7	143	14.5	143	18.6
60°	7000	500	19	– 20	– 10	10	23	– 24	8.6	– 8.6	7.8	142	16.5	142	18.2

FDB–1T–(173–3)

Figure 2-79 (U) (Sheet 3 of 8)

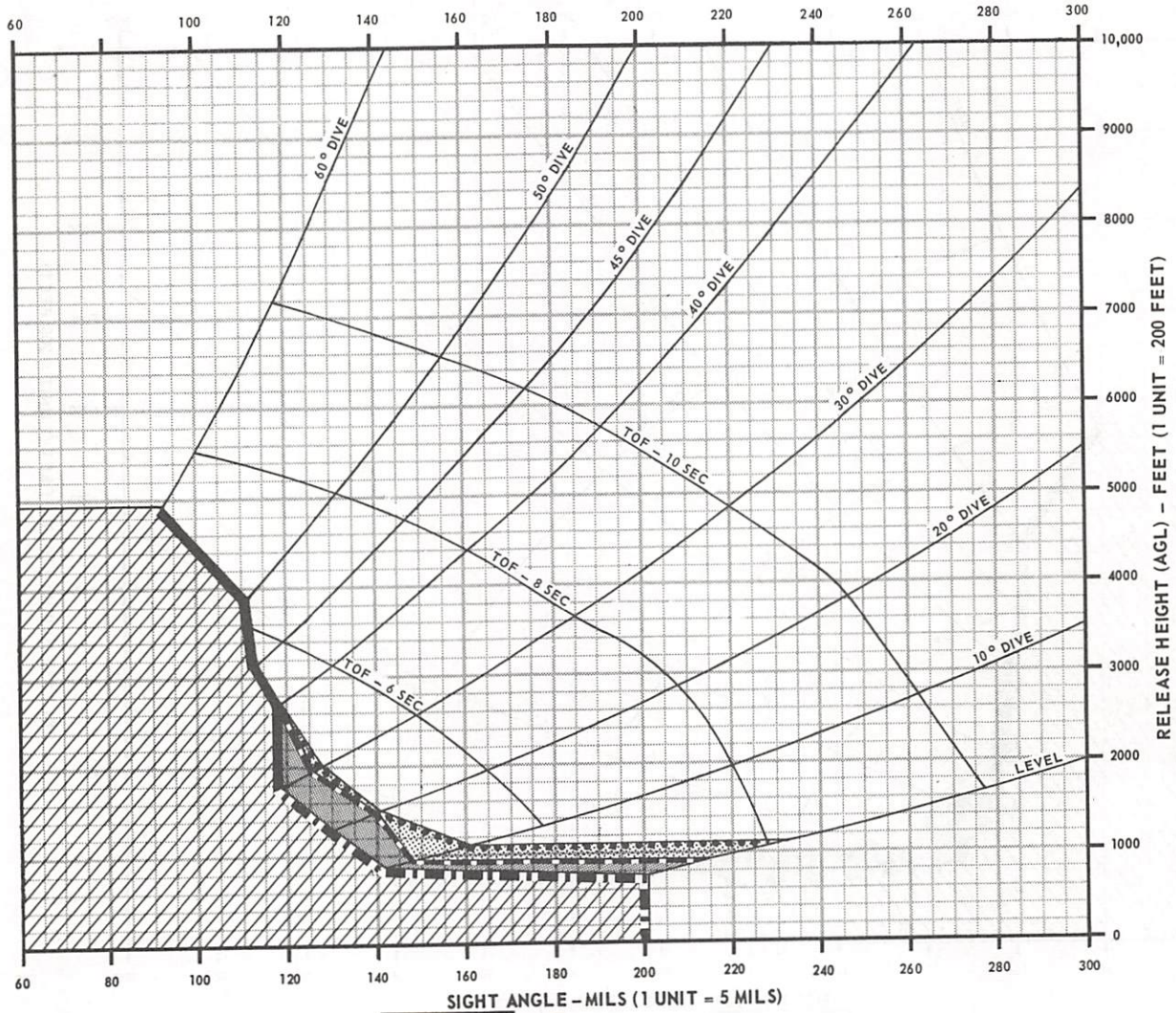
SIGHT ANGLE

MK 81 LDGP BOMB AND MK 86 PRACTICE BOMB (WET SAND FILLED)

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1100	232	1100	925	216	925	775	201	775
10	1100	161	825	950	148	675	875	142	600
20	1500	141	800	1475	140	775	1300	130	600
30	2000	128	725	1950	126	675	1775	119	500
40	2725	119	700	2725	119	700	2725	119	700
45	3150	114	700	3150	114	700	3150	114	700
50	3925	112	1000	3925	112	1000	3925	112	1000
60	4950	92	1000	4950	92	1000	4950	92	1000

FRAG
TERRAIN

NEW NEW NEW

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 81 LDGP: 270 LBS/7.2 FPS
MK 86 PRACTICE: 200 LBS/8.1 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(173-4)

Figure 2-79 (U) (Sheet 4 of 8)

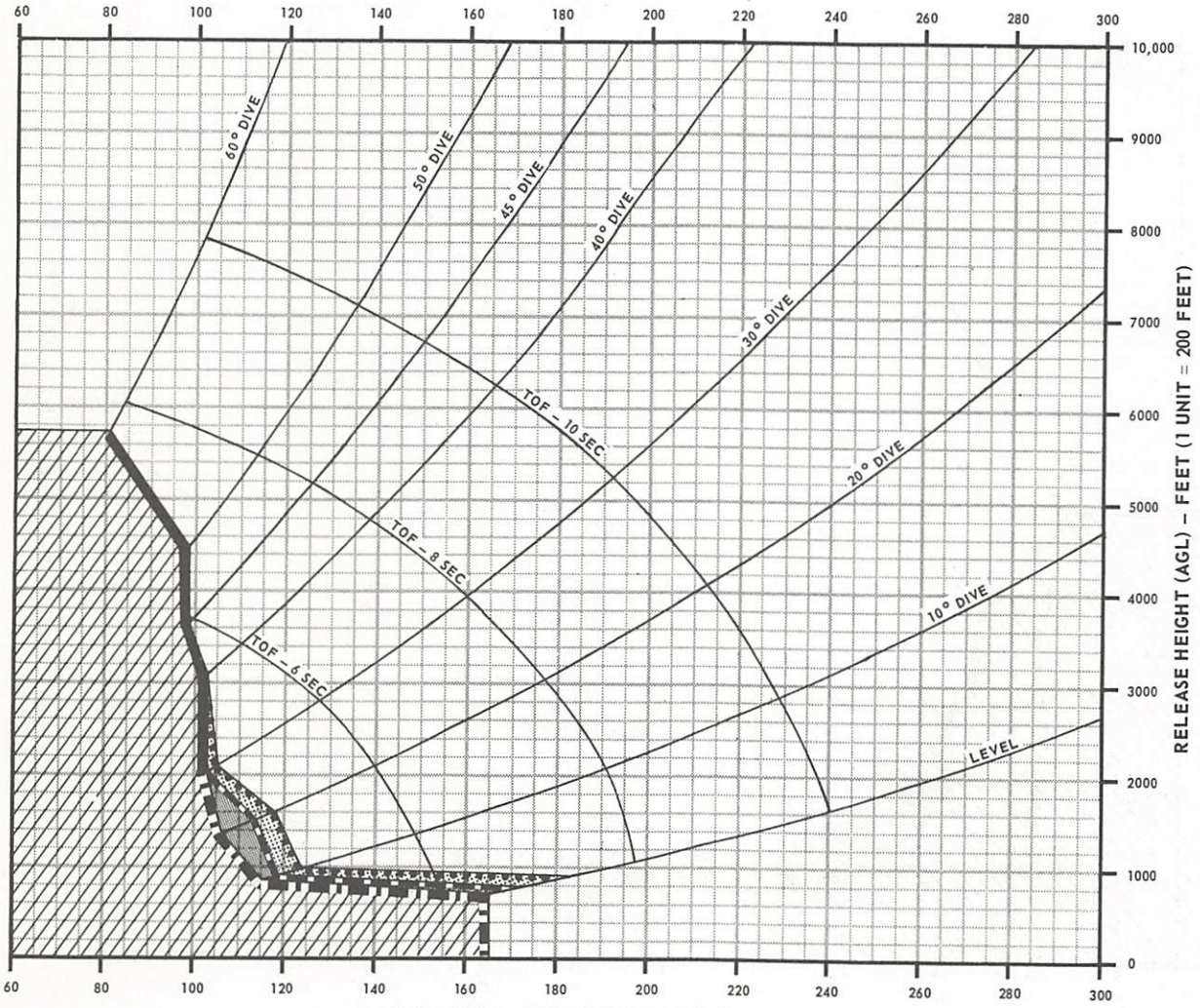
SIGHT ANGLE

MK 81 LDGP BOMB AND MK 86 PRACTICE BOMB (WET SAND FILLED)

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL									
DIVE ANGLE (DEG)	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	900	183	900	800	173	800	725	165	725
10	1000	124	675	925	119	600	875	115	550
20	1600	118	775	1525	114	700	1375	107	550
30	2100	105	575	2025	103	500	2025	103	500
40	3125	103	700	3125	103	700	3125	103	700
45	3650	99	700	3650	99	700	3650	99	700
50	4525	98	1000	4525	98	1000	4525	98	1000
60	5750	81	1000	5750	81	1000	5750	81	1000

FRAG

TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 81 LDGP: 270 LBS/7.2 FPS
MK 86 PRACTICE: 200 LBS/8.1 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(173-5)

NEW NEW NEW

Figure 2-79 (U) (Sheet 5 of 8)

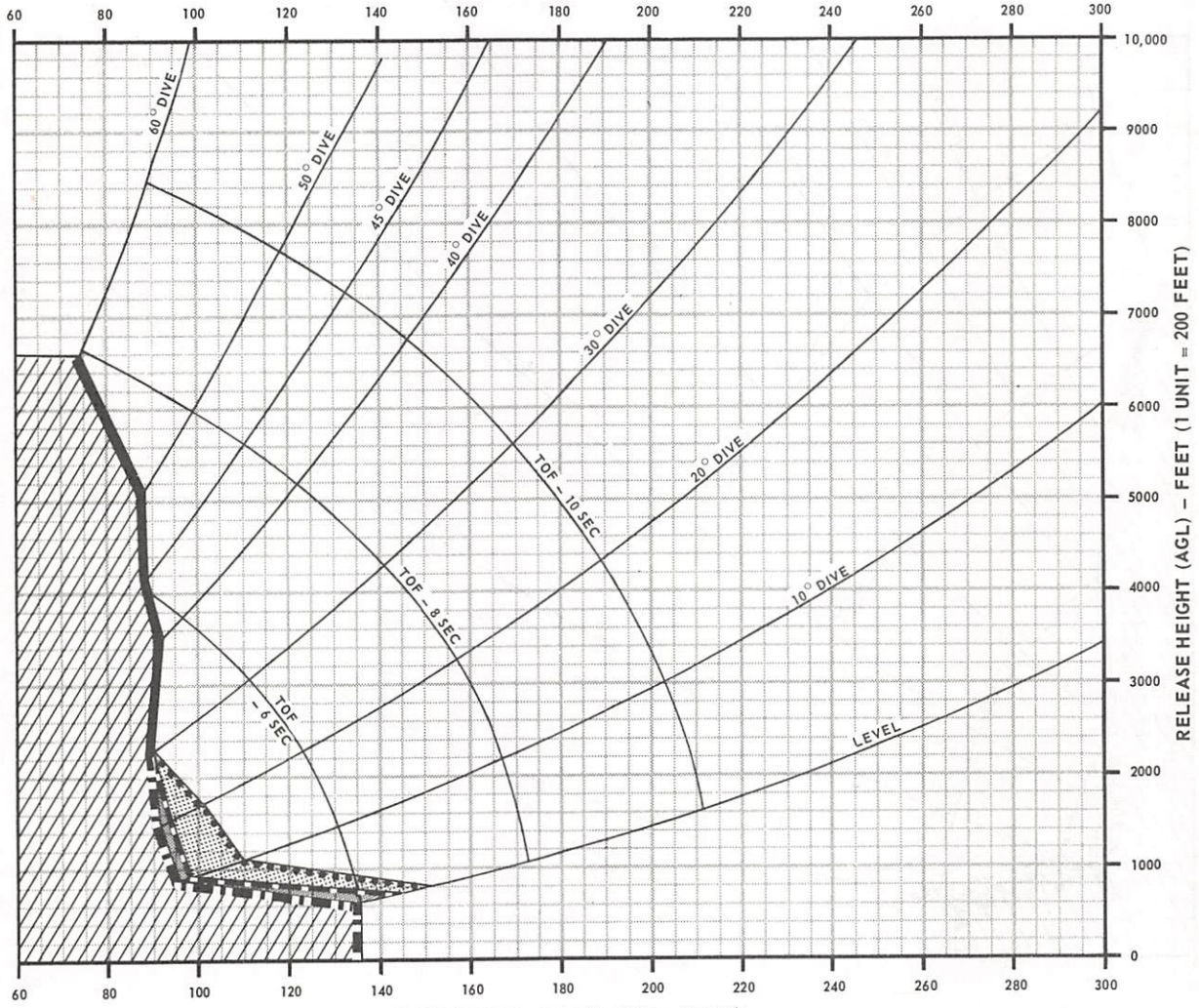
SIGHT ANGLE

MK 81 LDGP BOMB AND MK 86 PRACTICE BOMB (WET SAND FILLED)

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	800	152	800	725	145	725	625	136	625
10	1100	110	750	925	98	575	900	96	550
FRAG 20	1700	101	750	1525	94	575	1475	92	525
TERRAIN 30	2300	90	500	2300	90	500	2300	90	500
40	3550	93	700	3550	93	700	3550	93	700
45	4175	89	700	4175	89	700	4175	89	700
50	5125	88	1000	5125	88	1000	1525	88	1000
60	6600	74	1000	6600	74	1000	6600	74	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 81 LDGP: 270 LBS/7.2 FPS
MK 86 PRACTICE: 200 LBS/8.1 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB–1T–(173–6)

Figure 2-79 (U) (Sheet 6 of 8)

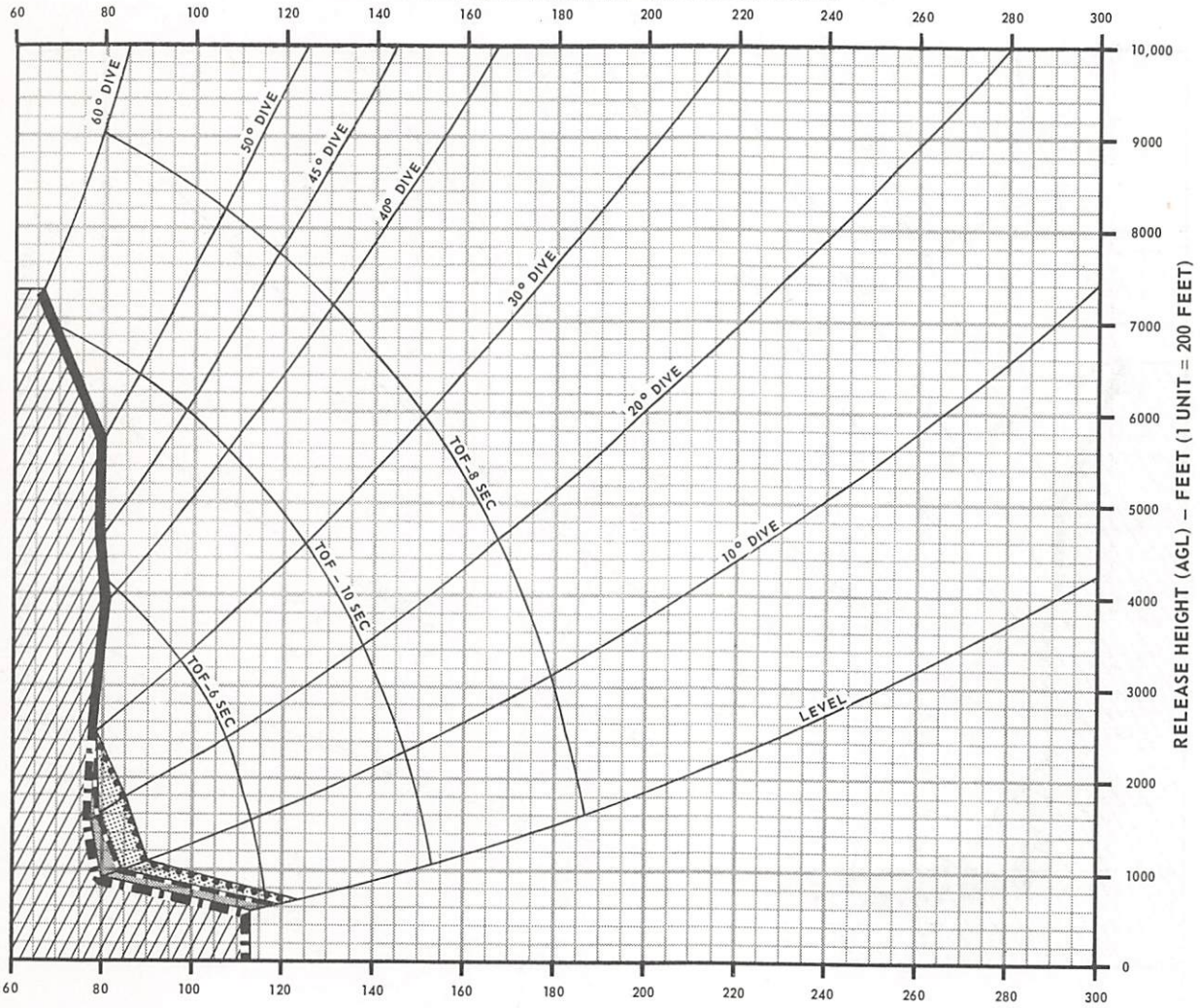
SIGHT ANGLE

MK 81 LDGP BOMB AND MK 86 PRACTICE BOMB (WET SAND FILLED)

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 7.2 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	700	124	700	625	118	625	575	113	575
10	1100	90	700	1000	84	600	925	80	525
20	1800	85	700	1625	79	525	1550	77	450
FRAG / TERRAIN 30	2550	79	500	2550	79	500	2550	79	500
40	3975	82	700	3975	82	700	3975	82	700
45	4675	80	700	4675	80	700	4675	80	700
50	5725	80	1000	5725	80	1000	5725	80	1000
60	7350	66	1000	7350	66	1000	7350	66	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 81 LDGP: 270 LBS/7.2 FPS
MK 86 PRACTICE: 200 LBS/8.1 FPS
*USED IN SIGHT ANGLE COMPUTATIONS.

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(173-7)

NEW NEW NEW

Figure 2-79 (U) (Sheet 7 of 8)

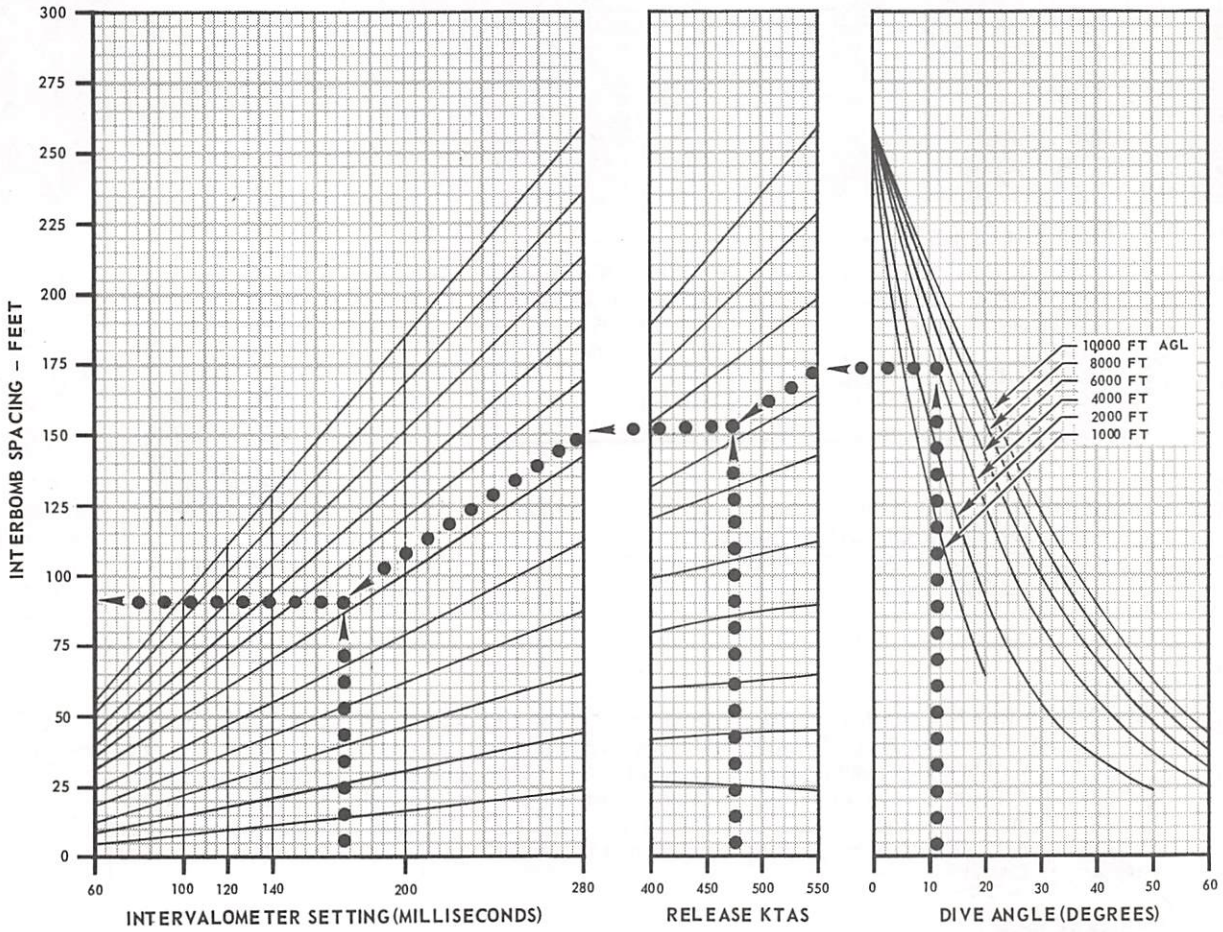
BOMB SPACING

MK81 LDGP BOMB AND MK86 PRACTICE BOMB (WET SAND FILLED)

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

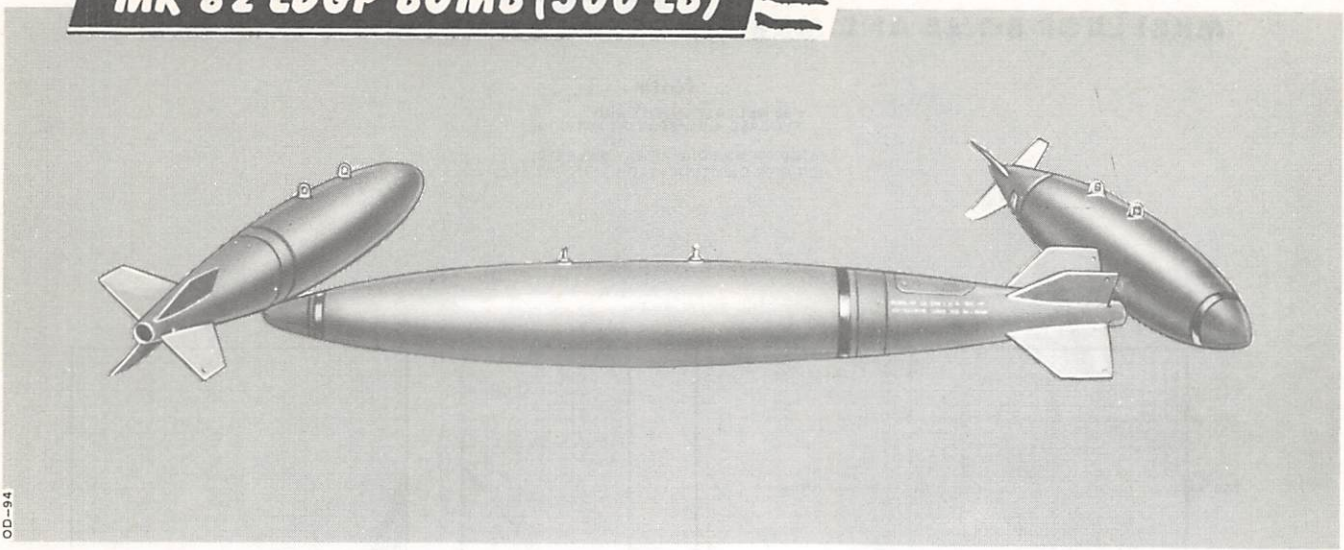
(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 7.2 FT/SEC)



UNCLASSIFIED
FDB-1T-(173-8)

Figure 2-79 (U) (Sheet 8 of 8)

MK 82 LDGP BOMB (500 LB)

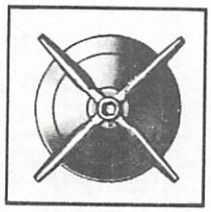


OD-94

CHARACTERISTICS

LENGTH	7 FEET 2 INCHES
DIAMETER	10.75 INCHES
EXPLOSIVE CHARGE	192 POUNDS
WEIGHT	531 POUNDS
SUSPENSION	14 INCHES
TOP OF FRAG PATTERN	2520 FEET

NEW



AFT VIEW

PAINTING AND MARKING
YELLOW BAND ON OLIVE DRAB BODY.
IDENTIFYING NOMENCLATURE ON BODY IN YELLOW.

DESCRIPTION

The MK 82 is a low drag, general-purpose bomb with a slender body, long pointed nose and conical tail fin assembly. The assembled bomb weighs 531 pounds and is attached to the airplane bomb rack by two suspension lugs located 14 inches apart. A hoisting lug is located between the 14 inch suspension lugs at the center of gravity to provide for handling of the bomb. Primary kill mechanisms are fragments and blast. Weapon type is antimaterial and antipersonnel. Optional fuzing may be obtained by installing VT, mechanical or electrical fuzes.

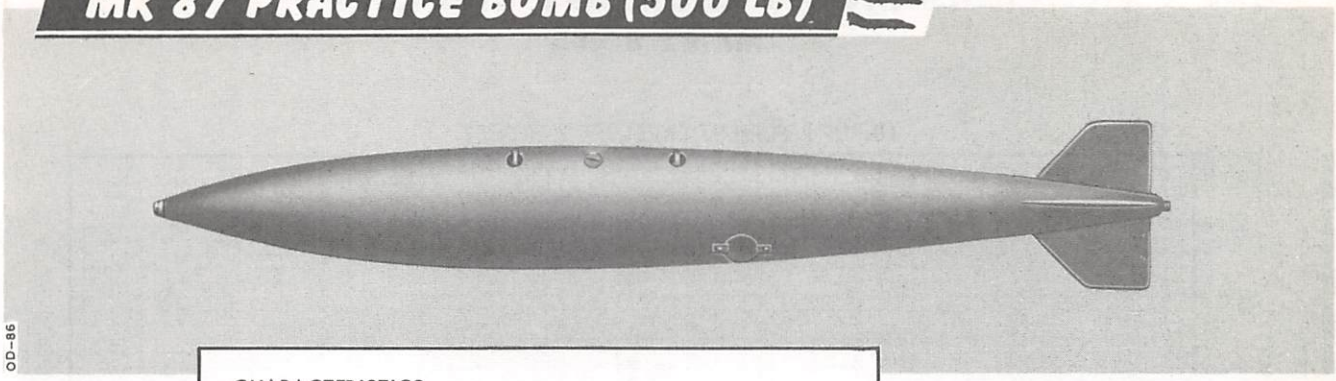
REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-2.1

FDB-1T-(174-1) UNCLASSIFIED

Figure 2-80 (U) (Sheet 1 of 8)

MK 87 PRACTICE BOMB (500 LB)

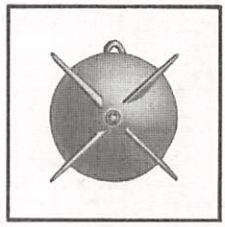


OD-86

CHARACTERISTICS:

LENGTH	7 1/2 FEET
DIAMETER	10.75 INCHES
WEIGHT (LOADED)	
WET SAND	330 POUNDS
SUSPENSION	14 INCHES

PAINTING AND MARKING
ORANGE BODY.
IDENTIFYING NOMENCLATURE
STENCILED IN WHITE.



AFT VIEW

DESCRIPTION

The Mod 0 bomb is a 500-pound practice bomb. It is a low-drag practice bomb, similar in size and shape to the MK 82 general purpose bomb. It has a long pointed nose and a conically tapered aft end. One filler hole is located on the side, aft of the rear suspension lug. The four tail fins are canted 1 1/2 degrees to impart spin to the bomb to insure good flight stability.

The 500-pound practice bomb is of thin-case construction with internal reinforcement for the sway brace and ejection areas. To provide rigidity, bulkheads and channel reinforcements are used on the inside of the bomb casing.

Firing Pin MK 1 Mod 0 and Practice Bomb Signal MK 4 Mod 3 are installed in the forward end of the bomb, and are secured by a cotter pin.

The bomb is filled with 235 pounds of wet sand or 123 pounds of water. Two suspension lugs (MK 6 Mod 0) are spaced 14 inches apart on the body. A hoisting lug is located midway between the suspension lugs.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.

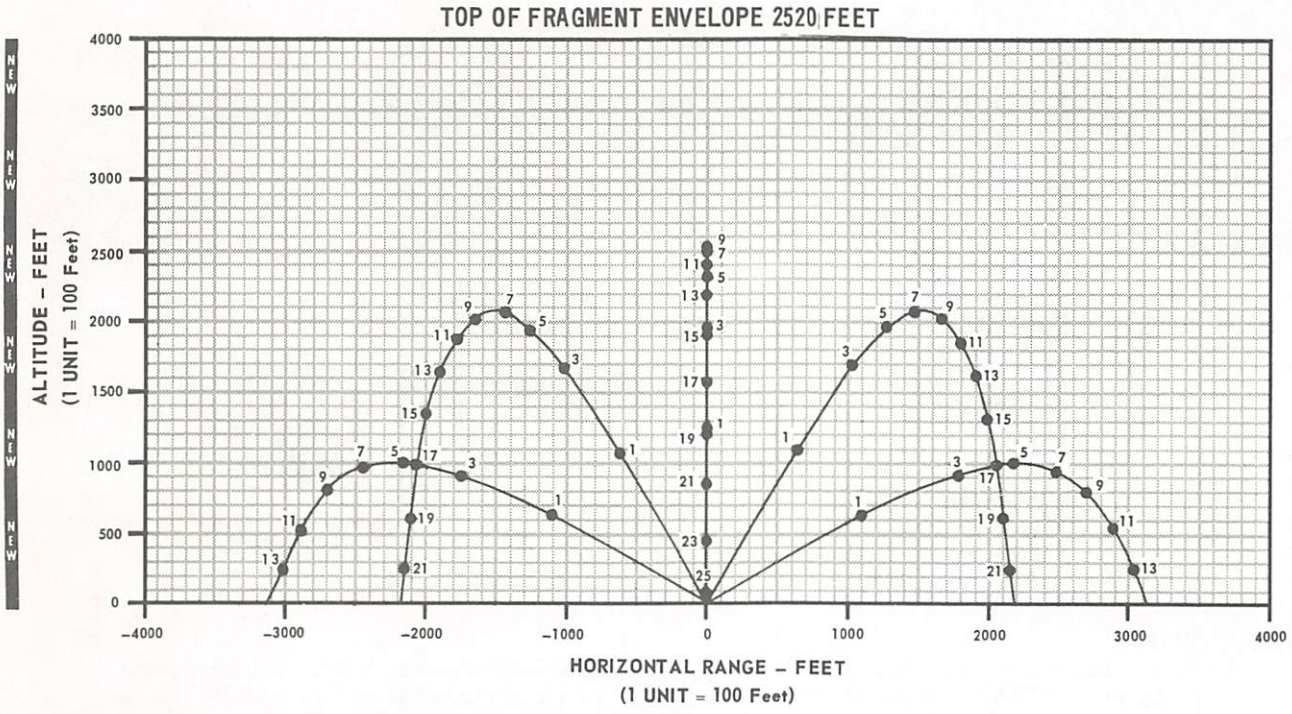
UNCLASSIFIED

FDB-1T-(174-2)

Figure 2-80 (U) (Sheet 2 of 8)

MAXIMUM FRAGMENT ENVELOPE

MK 82 BOMB



RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 82 LDGP, MK 36 DESTRUCTOR AND MK 87/124 PRACTICE BOMB-CONICAL FIN

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT Slant Range 1000 Ft	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL		FT	MILS	FT	MILS
0°	1500	450	154	–154	–240	230	274	–365	34.0	–35.7	7.2	160	4.6	161	22.3
20°	2000	450	37	–38	–40	40	35	– 41	9.8	–10.0	4.5	96	9.7	97	21.5
30°	3000	450	31	–33	– 20	20	26	– 29	8.4	–8.5	5.0	106	12.6	105	21.1
	5000	500	52	–53	–30	30	49	– 54	13.0	–13.2	8.1	152	11.6	151	18.7
45°	4000	450	21	– 22	–10	10	17	– 19	6.7	– 6.8	5.2	107	15.8	107	20.6
	6000	500	30	– 32	–10	10	29	– 31	9.8	–9.9	7.7	141	14.3	141	18.3
60°	7000	500	18	–19	–10	10	22	– 23	8.6	– 8.6	7.8	139	16.2	140	18.0

UNCLASSIFIED

FDB-1T-(174-4)

Figure 2-80 (U) (Sheet 3 of 8)

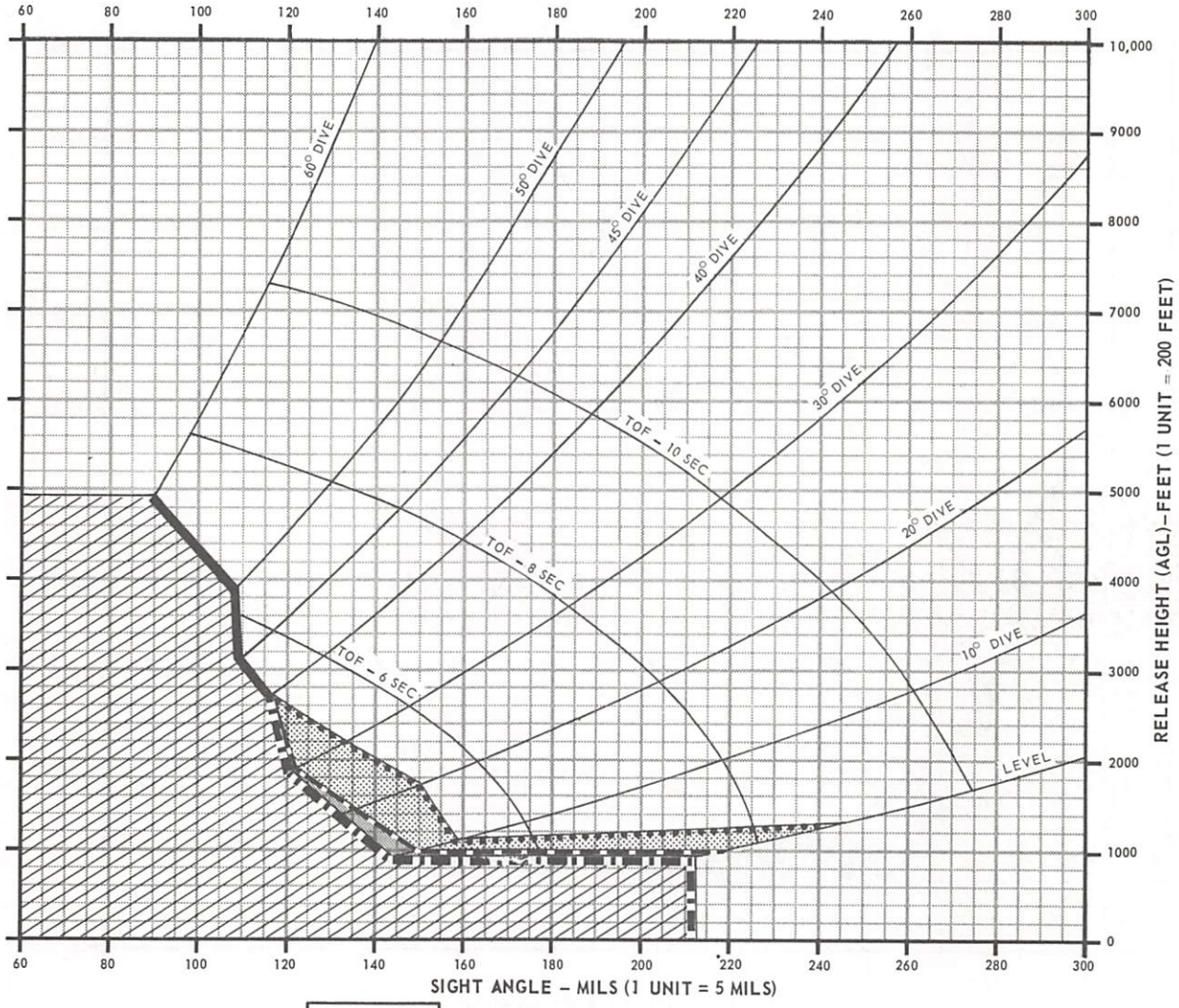
SIGHT ANGLE

MK 82 LDGP, MK 36 DESTRUCTOR AND MK 87/124 PRACTICE-CONICAL FIN

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1300	247	1300	1000	220	1000	925	213	925
10	1100	158	825	1000	150	725	925	144	650
20	1700	150	1000	1450	136	750	1400	134	700
30	2200	134	925	1900	122	625	1875	121	600
FRAG / TERRAIN									
40	2725	117	700	2725	117	700	2725	117	700
45	3150	112	700	3150	112	700	3150	112	700
50	3925	109	1000	3925	109	1000	3925	109	1000
60	4950	90	1000	4950	90	1000	4950	90	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

*MK82 LDGP: 531 LBS/6.0 FPS
MK36 DESTRUCTOR: 531 LBS/6.0 FPS
MK87 PRACTICE: 330 LBS/7.2 FPS
MK 124 PRACTICE: 565 LBS/6.0 FPS

*USED IN SIGHT ANGLE COMPUTATIONS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB–1T–(174–5)

Figure 2-80 (U) (Sheet 4 of 8)

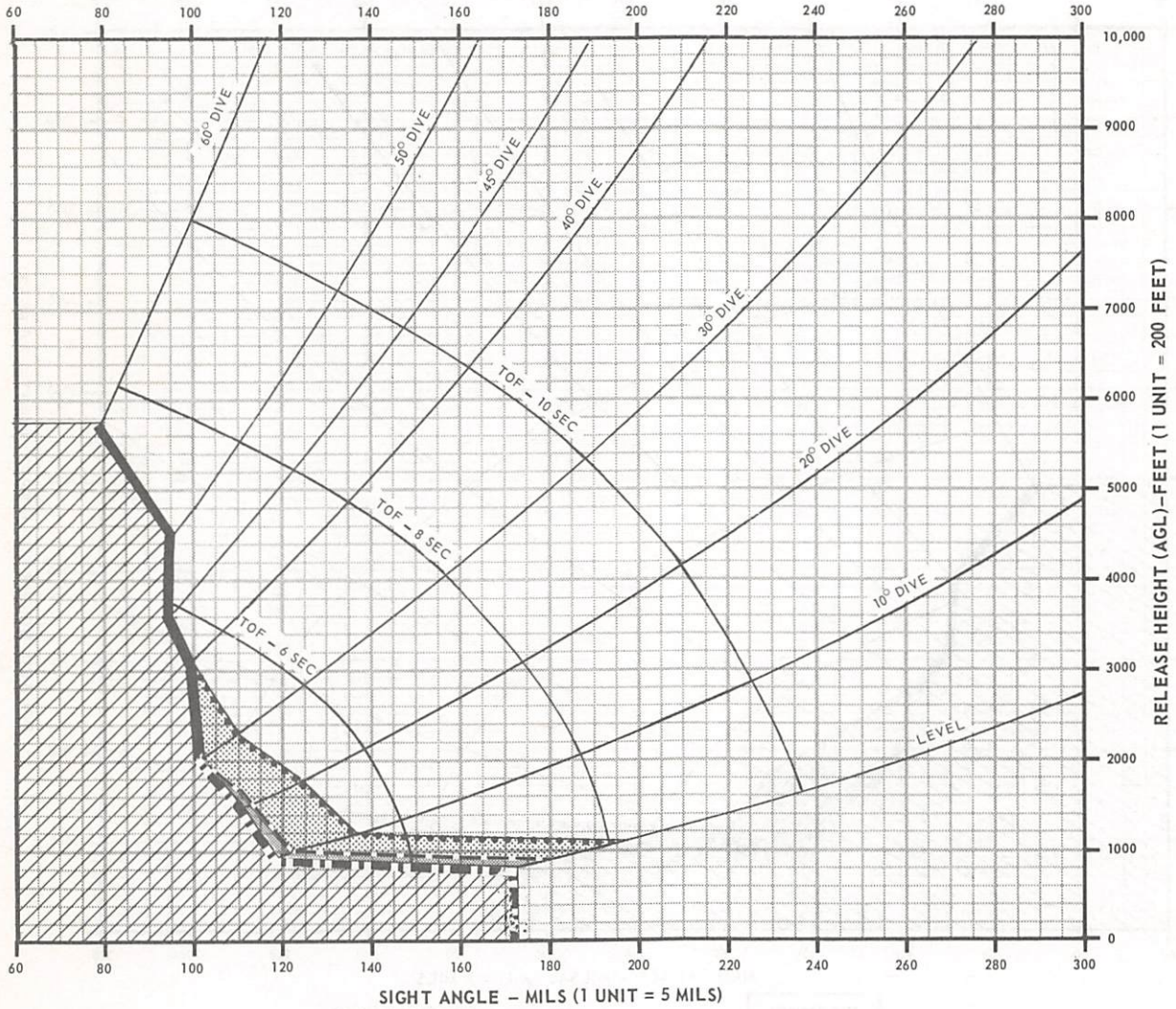
SIGHT ANGLE

MK 82 LDGP, MK 36 DESTRUCTOR AND MK 87/124 PRACTICE-CONICAL FIN

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1100	197	1100	900	181	900	825	173	825
10	1200	136	875	1000	122	675	950	119	625
20	1800	124	975	1500	111	675	1475	110	650
30	2300	109	775	2025	101	500	2025	101	500
40	3125	100	700	3125	100	700	3125	100	700
45	3650	96	700	3650	96	700	3650	96	700
50	4525	96	1000	4525	96	1000	4525	96	1000
60	5750	79	1000	5750	79	1000	5750	79	1000

FRAG
TERRAIN

NEW NEW NEW

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

*MK82 LDGP: 531 LBS/6.0 FPS
MK36 DESTRUCTOR: 531 LBS/6.0 FPS
MK87 PRACTICE: 330 LBS/7.2 FPS
MK 124 PRACTICE: 565 LBS/6.0 FPS

* USED IN SIGHT ANGLE COMPUTATIONS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(174-6)

Figure 2-80 (U) (Sheet 5 of 8)

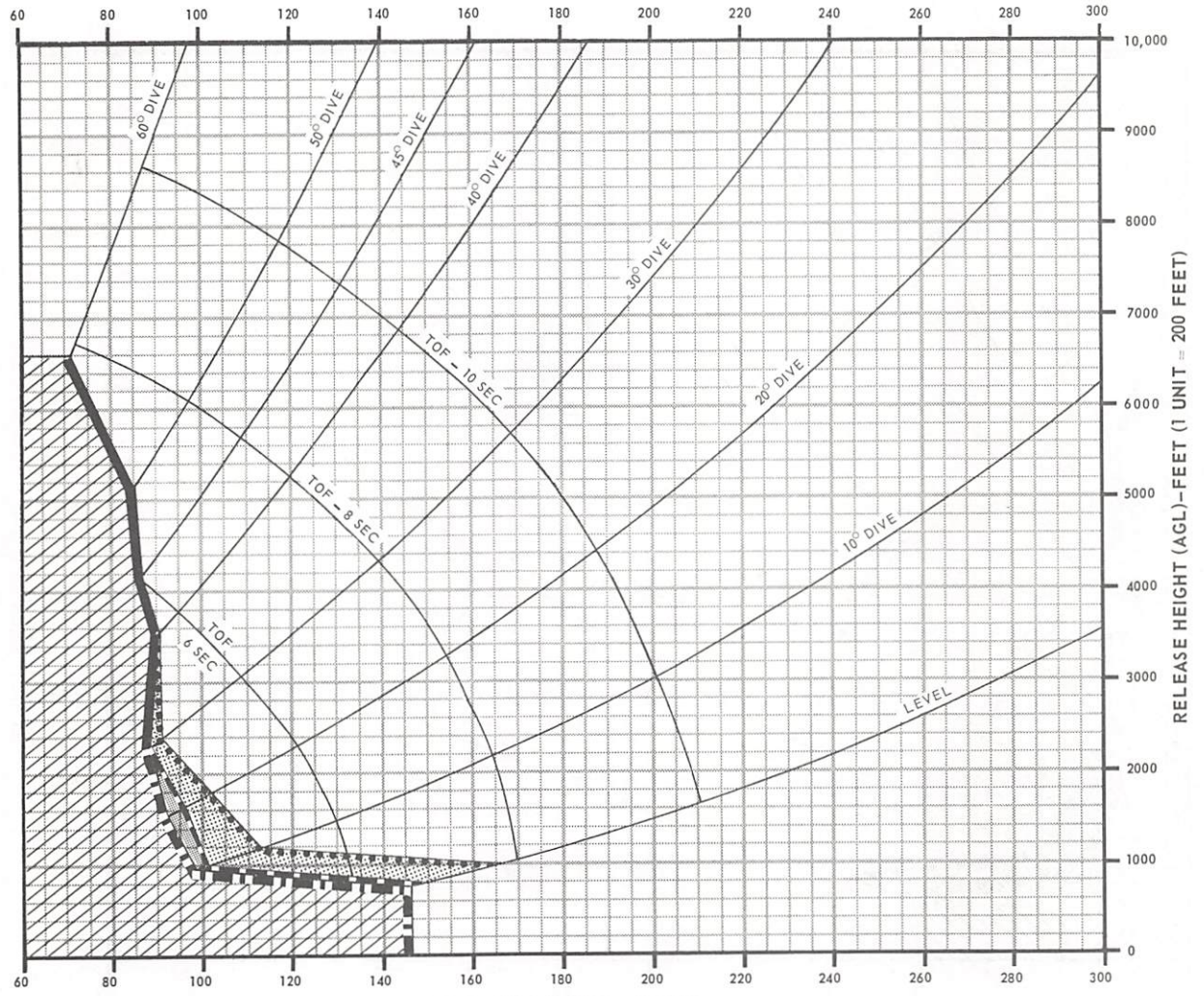
SIGHT ANGLE

MK 82 LDGP, MK 36 DESTRUCTOR AND MK 87/124 PRACTICE-CONICAL FIN

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1000	167	1000	800	150	800	775	147	775
10	1200	113	850	1000	102	650	975	99	625
20	1800	102	850	1625	96	675	1550	93	600
30	2400	91	600	2300	88	500	2300	88	500
FRAG / TERRAIN									
40	3550	91	700	3550	91	700	3550	91	700
45	4175	87	700	4175	87	700	4175	87	700
50	5125	86	1000	5125	86	1000	5125	86	1000
60	6600	71	1000	6600	71	1000	6600	71	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VALOCITY:

*MK82 LDGP: 531 LBS/6.0 FPS
MK36 DESTRUCTOR: 531 LBS/6.0 FPS
MK87 PRACTICE: 330 LBS/7.2 FPS
MK 124 PRACTICE: 565 LBS/6.0 FPS

*USED IN SIGHT ANGLE COMPUTATIONS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB–1T–(174–7)

Figure 2-80 (U) (Sheet 6 of 8)

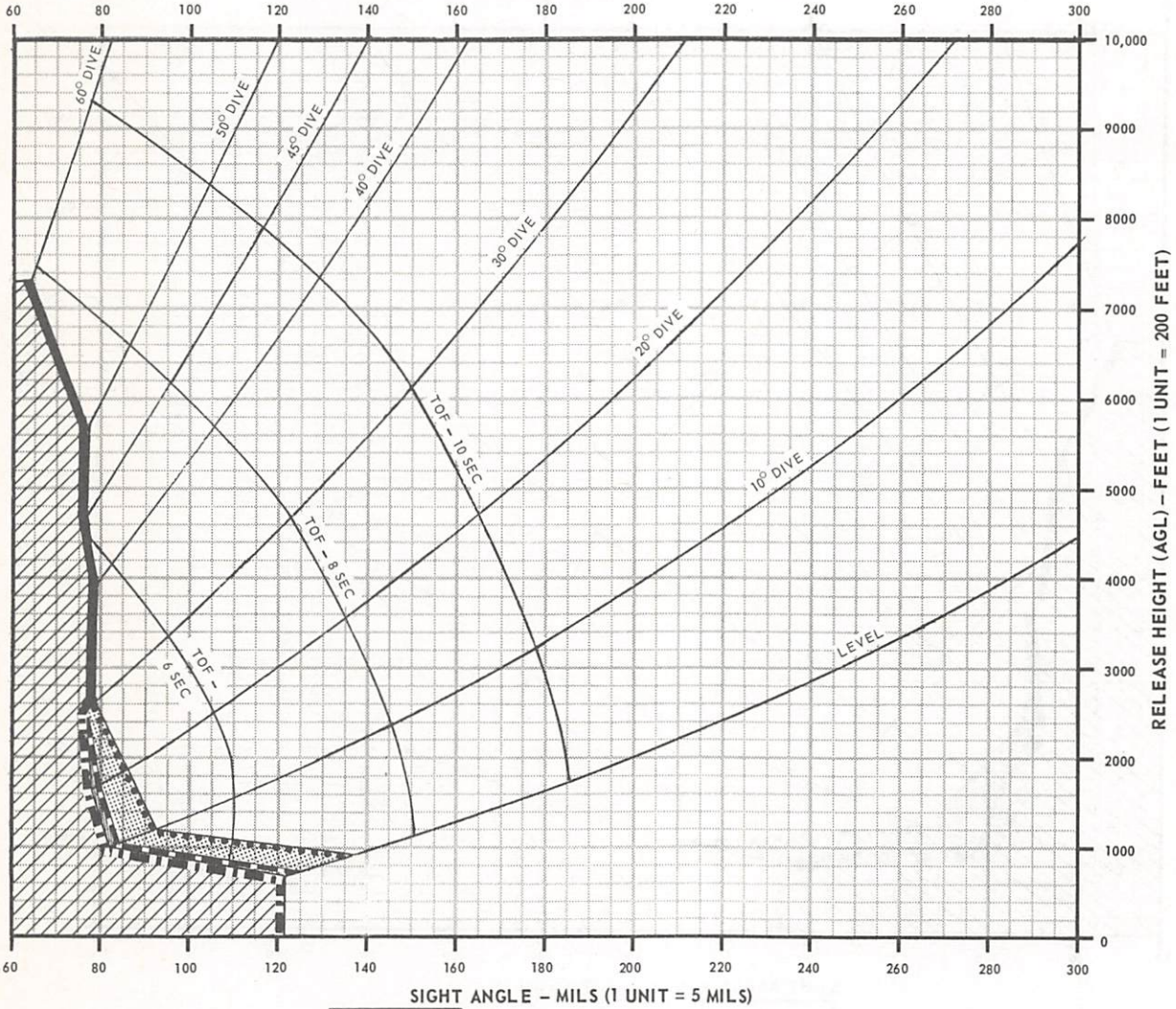
SIGHT ANGLE

MK 82 LDGP, MK 36 DESTRUCTOR AND MK 87/124 PRACTICE-CONICAL FIN

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	900	138	900	750	126	750	700	122	700
10	1200	93	800	1025	84	625	1000	82	600
20	1900	86	800	1700	80	600	1650	78	550
30	2600	79	550	2550	77	500	2550	77	500
40	3975	80	700	3975	80	700	3975	80	700
45	4675	78	700	4675	78	700	4675	78	700
50	5725	78	1000	5725	78	1000	5725	78	1000
60	7350	64	1000	7350	64	1000	7350	64	1000

FRAG

TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

*MK 82 LDGP: 531 LBS/6.0 FPS
MK 36 DESTRUCTOR: 531 LBS/6.0 FPS
MK 87 PRACTICE: 330 LBS/7.2 FPS
MK 124 PRACTICE: 565 LBS/6.0 FPS

*USED IN SIGHT ANGLE COMPUTATIONS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(174-8)

NEW NEW NEW

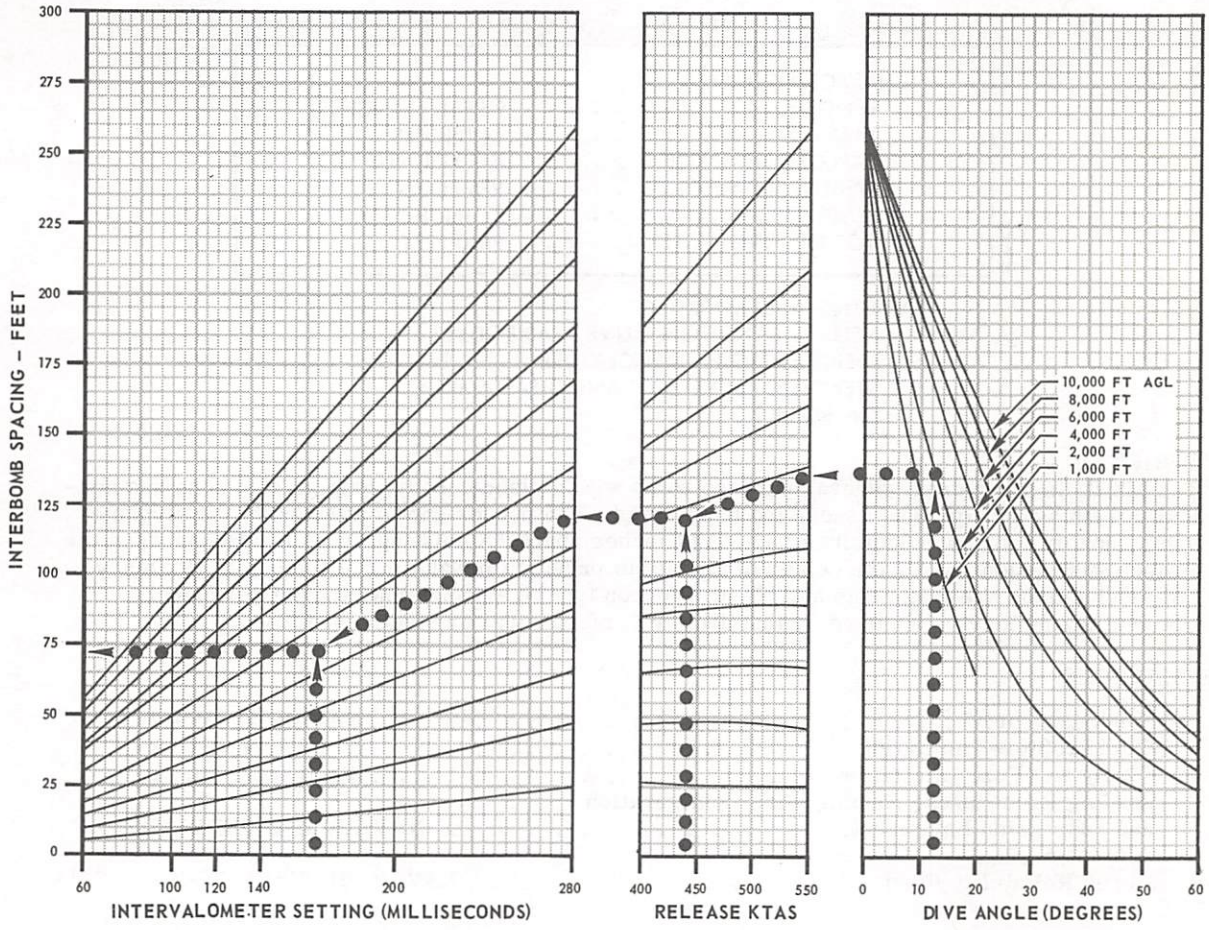
Figure 2-80 (U) (Sheet 7 of 8)

BOMB SPACING

MK 82 LDGP, MK 36 DESTRUCTOR AND MK 87/124 PRACTICE-CONICAL FIN

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB
(BASED ON SIX BOMB RIPPLE RELEASE,
MER–TER EJECTION VELOCITY 6.0 FT/SEC)

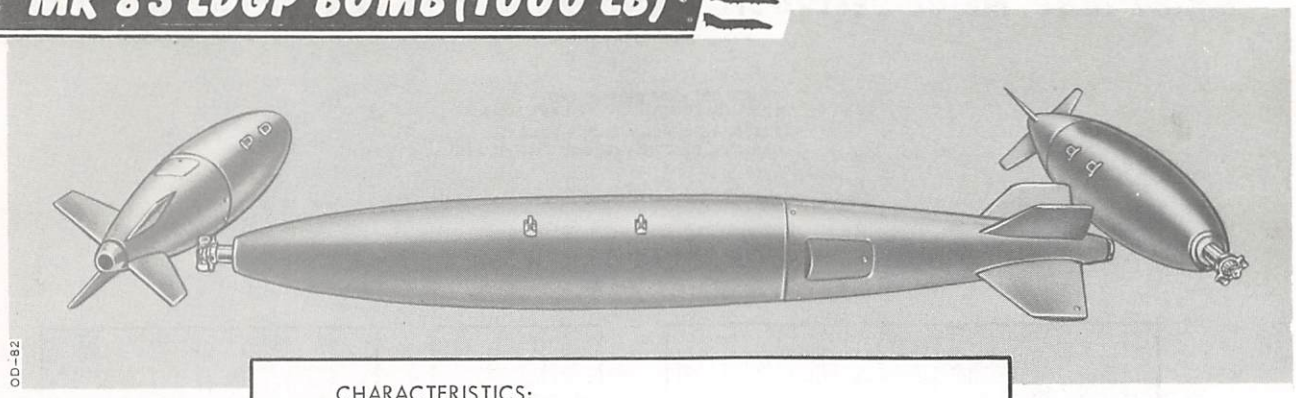


UNCLASSIFIED

FDB–1T–(174–9)

Figure 2-80 (U) (Sheet 8 of 8)

MK 83 LDGP BOMB (1000 LB)



OD-82

CHARACTERISTICS:

LENGTH	9 FEET 11 INCHES
DIAMETER	14 INCHES
EXPLOSIVE CHARGE	445 POUNDS
WEIGHT (LOADED)	985 POUNDS
SUSPENSION	14 INCHES
TOP OF FRAG PATTERN	2820 FEET

3-82

PAINTING AND MARKING
YELLOW BANDS ON OLIVE DRAB BODY.
IDENTIFYING NOMENCLATURE
STENCILED IN YELLOW AND DIE-STAMPED
ON BOMB BODY.

DESCRIPTION

The MK 83 is a low drag, general-purpose bomb with a slender body, long pointed nose and conical tail fin assembly. The assembled bomb weighs 985 pounds and is attached to the airplane bomb rack by two suspension lugs located 14 inches apart. A hoisting lug is located between the 14 inch suspension lugs at the center of gravity to provide for handling of the bomb. Primary kill mechanisms are fragments and blast. Weapon type is antimaterial and antipersonnel. Optional fuzing may be obtained by installing VT, mechanical or electrical fuzes.

REFERENCES

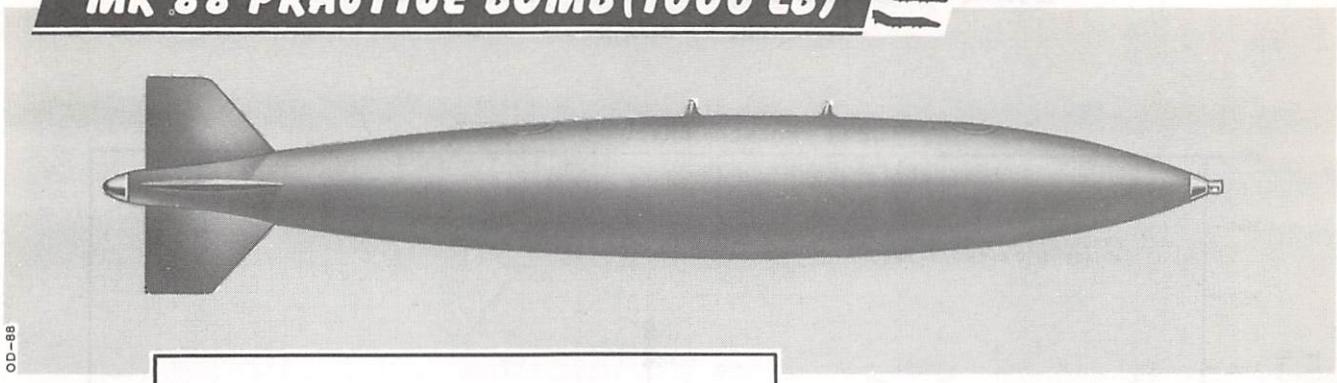
1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-2.1

UNCLASSIFIED

FDB-1T-(175-1)

Figure 2-81 (U) (Sheet 1 of 8)

MK 88 PRACTICE BOMB (1000 LB)

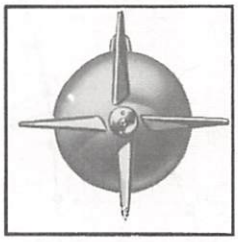


OD-88

LENGTH	9 FEET 11 INCHES
DIAMETER	14 INCHES
WEIGHT (LOADED)	
WET SAND	794 POUNDS
SUSPENSION	14 INCHES

PAINTING AND MARKING
ORANGE BODY.
IDENTIFYING NOMENCLATURE
STENCILED IN WHITE.

AFT VIEW



DESCRIPTION

The MK 88 Mod 0 bomb is a 1000 pound practice bomb used to simulate the MK 83 LDGP bomb trajectory. It has a long slender body and is constructed of thin sheet metal with internal reinforcement for the sway brace and ejection areas. Internal bulkheads and channel reinforcements provide for rigidity of the casing. The bomb has a sharp nose and a tapered aft end to which four fin blades are attached. The blades are set perpendicular to the axis of the bomb, approximately 5.5 inches forward of the tail end, and are canted 2 degrees for added stability. Two filling holes are located topside in the bomb body and are sealed with filler caps. A single hoisting lug is screwed into the body over the approximate center of gravity. Two suspension lugs, 14 inches apart and equidistant from the hoisting lug, are threaded into recesses in the bomb body. A blast tube, extending the length of the bomb, houses a pyrotechnic charge and firing-pin assembly. The bomb is filled either with water or with a mixture of water and sand. Antifreeze must be added under freezing conditions to prevent bursting of the bomb case caused by freezing of the filler.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.

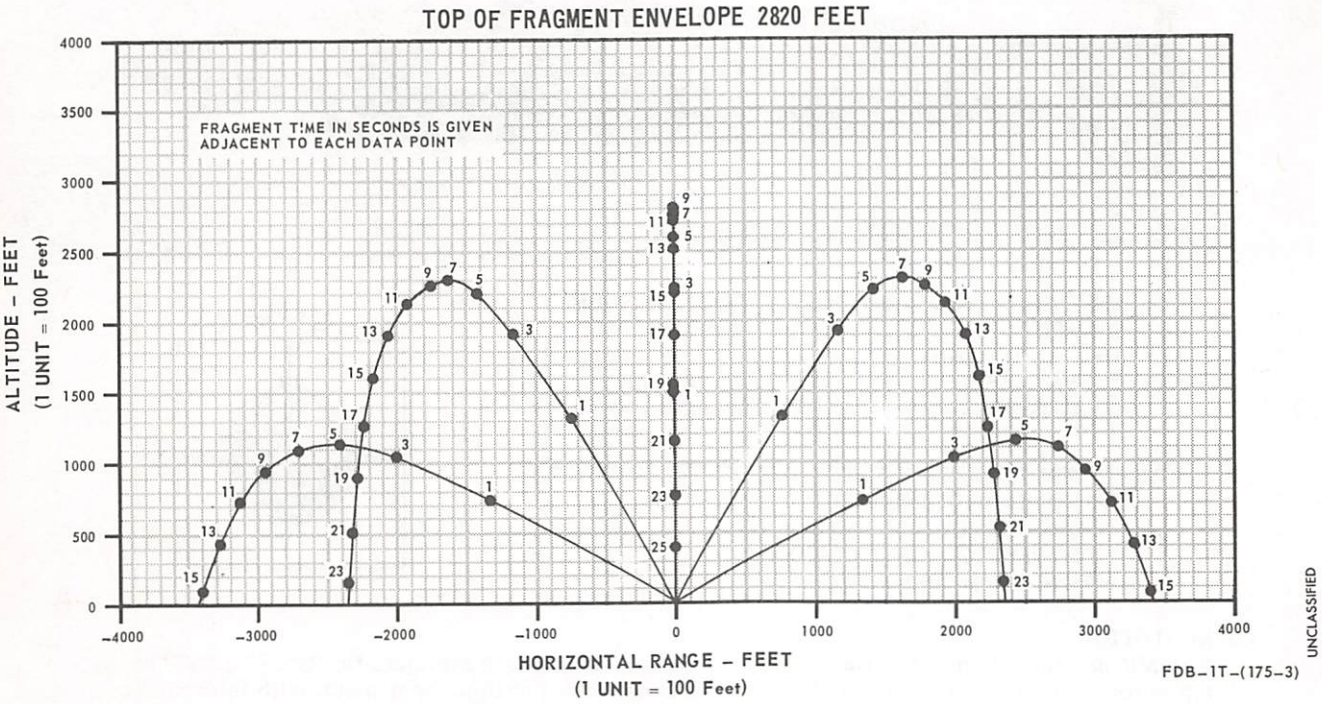
UNCLASSIFIED

FDB-1T-(175-2)

Figure 2-81 (U) (Sheet 2 of 8)

MAXIMUM FRAGMENT ENVELOPE

MK 83 BOMB



UNCLASSIFIED

FDB–1T–(175–3)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 83 LDGP, MK 40 DESTRUCTOR AND MK 88 PRACTICE-CONICAL FIN

RELEASE PARAMETER			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KNOTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL	Slant Range 1000 Ft	FT	MIL	FT	MIL
0°	1500	500	156	–157	–270	260	333	–459	42.2	–44.5	8.1	160	3.7	162	20.0
10°	1500	450	63	– 64	–100	90	79	–100	15.9	–16.4	4.9	107	6.6	107	21.8
20°	2000	450	37	– 38	– 40	40	35	– 41	9.9	–10.1	4.5	96	9.6	96	21.4
30°	3000	450	31	– 33	– 20	20	26	– 29	8.4	– 8.5	5.0	106	12.5	105	20.9
	5000	500	52	– 53	– 30	30	49	– 54	13.1	–13.2	8.1	151	11.5	151	18.6
45°	4000	450	21	– 21	– 10	10	17	– 18	6.7	– 6.8	5.2	106	15.7	107	20.5
	6000	500	30	– 31	– 10	10	29	– 31	9.9	–10.0	7.7	140	14.1	140	18.2
60°	7000	500	18	– 19	– 10	10	22	– 23	8.6	– 8.7	7.8	139	16.1	140	17.9

UNCLASSIFIED

FDB–1T–(175–4)

Figure 2-81 (U) (Sheet 3 of 8)

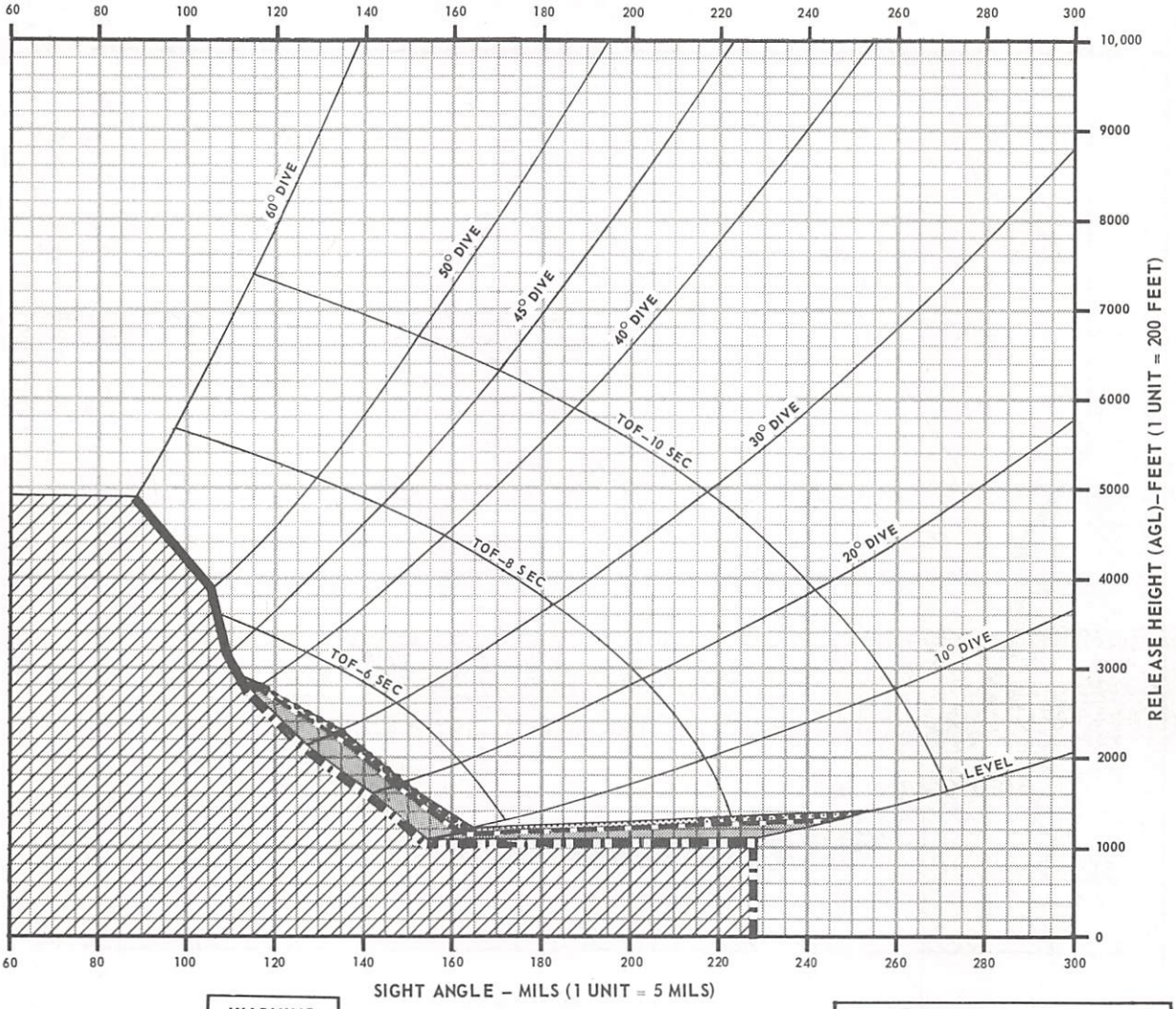
SIGHT ANGLE

MK 83 LDGP BOMB, MK 40 DESTRUCTOR AND MK 88 PRACTICE-CONICAL FIN

400 KTAS RELEASE

Notes

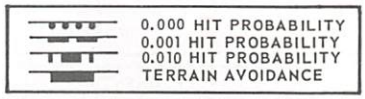
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1400	253	1400	1350	249	1350	1100	227	1100
10	1200	165	925	1175	163	900	1075	155	800
20	1700	149	1000	1675	147	975	1600	142	900
30	2300	136	1025	2250	134	975	2100	128	825
FRAG 40	2800	117	775	2750	116	725	2725	115	700
TERRAIN 45	3150	110	700	3150	110	700	3150	110	700
50	3925	107	1000	3925	107	1000	3925	107	1000
60	4950	88	1000	4950	88	1000	4950	88	1000



WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 83 LDGP: 985 LBS/4.8 FPS
MK 88 PRACTICE: 750 LBS/5.2 FPS
MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

UNCLASSIFIED

FDB-1T-(175-5)

Figure 2-81 (U) (Sheet 4 of 8)

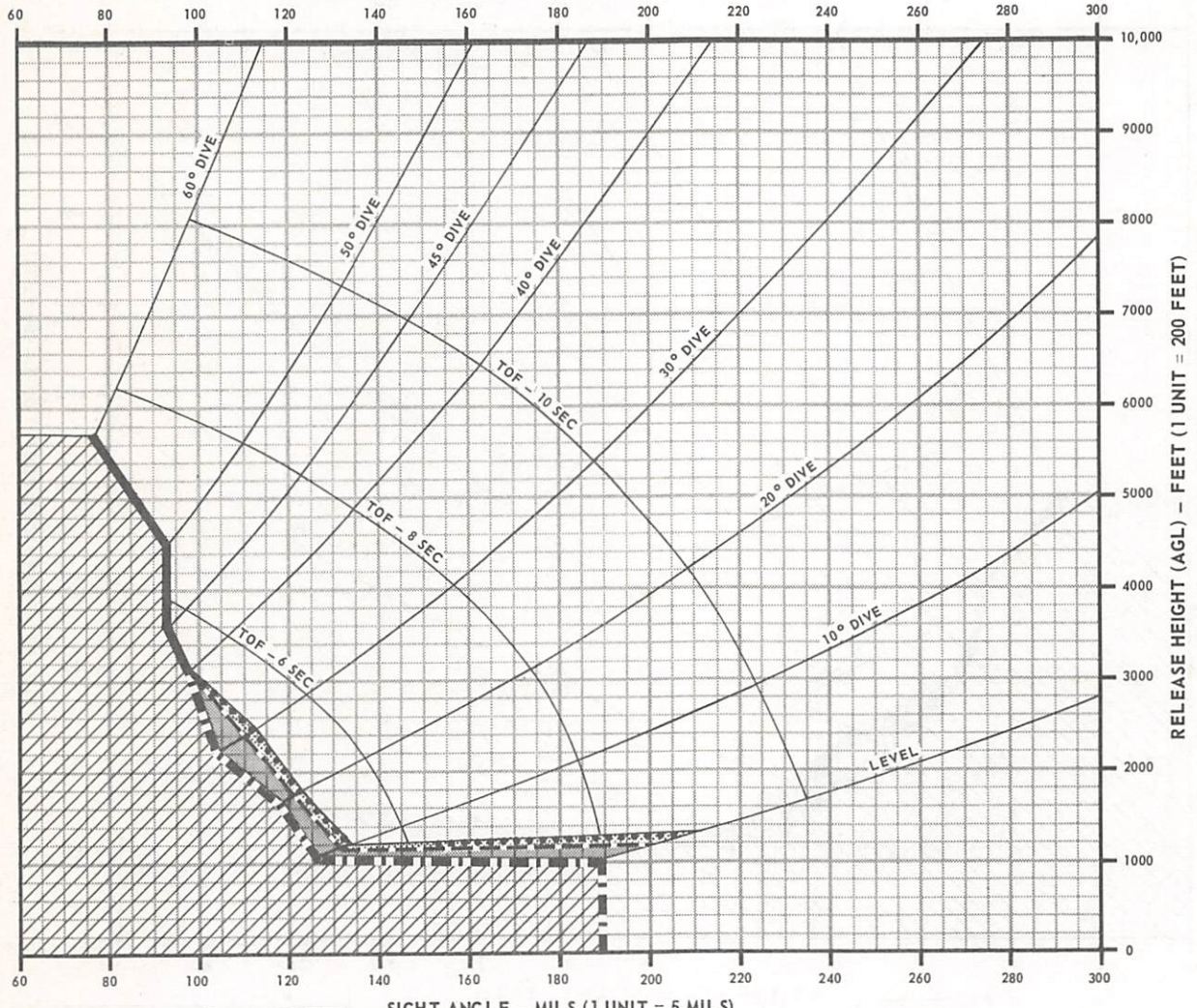
SIGHT ANGLE

MK 83 LDGP BOMB, MK 40 DESTRUCTOR AND MK 88 PRACTICE-CONICAL FIN

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS)



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1300	211	1300	1200	203	1200	1025	190	1025
10	1200	134	875	1150	131	825	1075	126	750
20	1800	123	975	1775	121	950	1675	117	850
FRAG 30	2500	113	975	2400	110	875	2225	105	700
TERRAIN 40	3125	99	700	3125	99	700	3125	99	700
45	3650	94	700	3650	94	700	3650	94	700
50	4525	94	1000	4525	94	1000	4525	94	1000
60	5750	77	1000	5750	77	1000	5750	77	1000

NEW NEW NEW

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
*MK 83 LDGP: 985 LBS/4.8 FPS
MK 88 PRACTICE: 750 LBS/5.2 FPS
MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

UNCLASSIFIED

FDB-1T-(175-6)

Figure 2-81 (U) (Sheet 5 of 8)

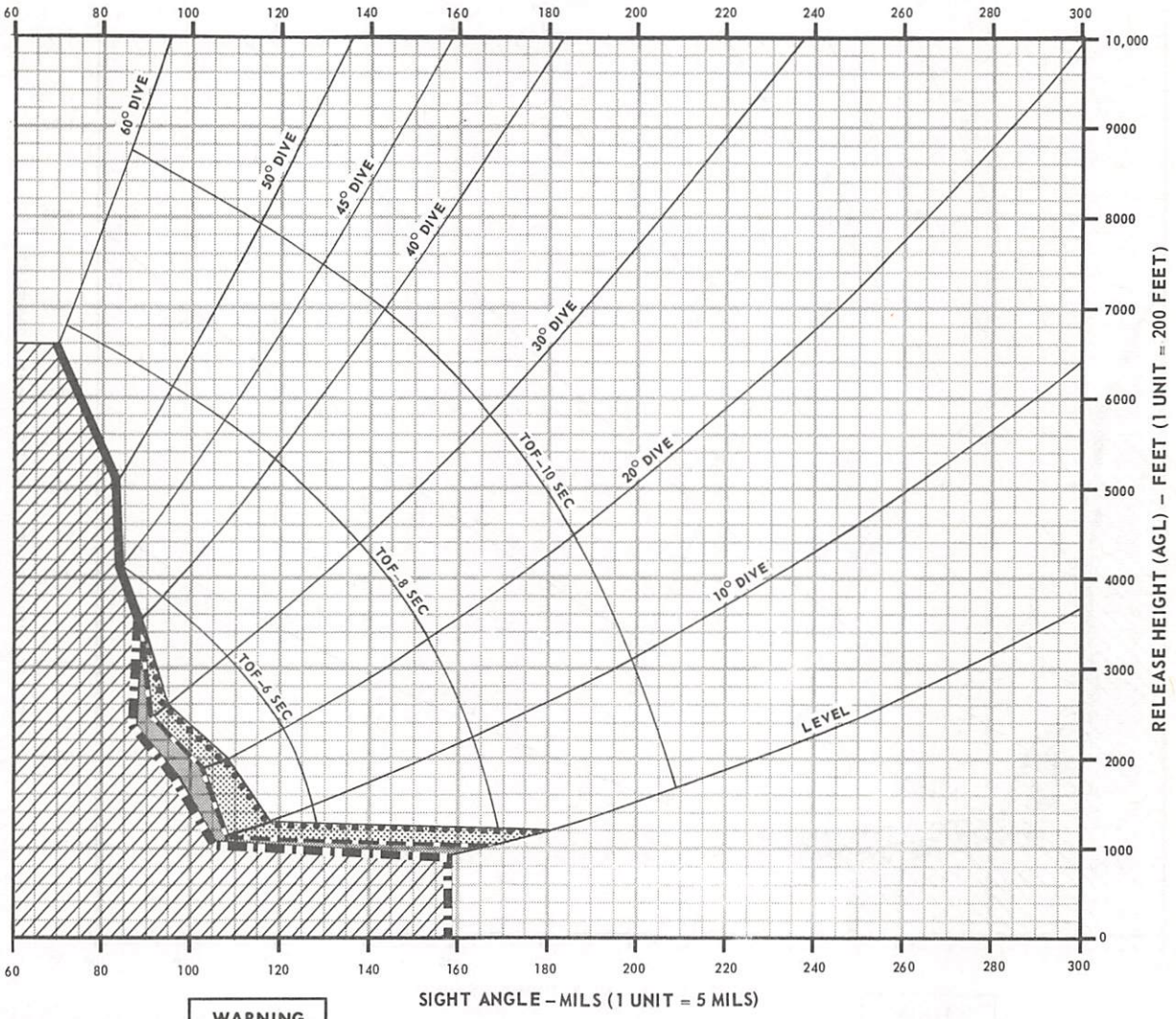
SIGHT ANGLE

MK 83 LDGP BOMB, MK 40 DESTRUCTOR AND MK 88 PRACTICE-CONICAL FIN

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1200	179	1200	1075	171	1075	925	158	925
10	1300	117	950	1125	107	775	1100	106	750
20	2000	108	1050	1815	103	925	1750	98	800
30	2600	95	800	2525	93	725	2375	88	575
FRAG / TERRAIN									
40	3550	89	700	3550	89	700	3550	89	700
45	4175	85	700	4175	85	700	4175	85	700
50	5125	84	1000	5125	84	1000	5125	84	1000
60	6600	70	1000	6600	70	1000	6600	70	1000

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:
*MK 83 LDGP: 985 LBS/4.8 FPS
MK 88 PRACTICE: 750 LBS/5.2 FPS
MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

UNCLASSIFIED

FDB–ITA–(175-7)

Figure 2-81 (U) (Sheet 6 of 8)

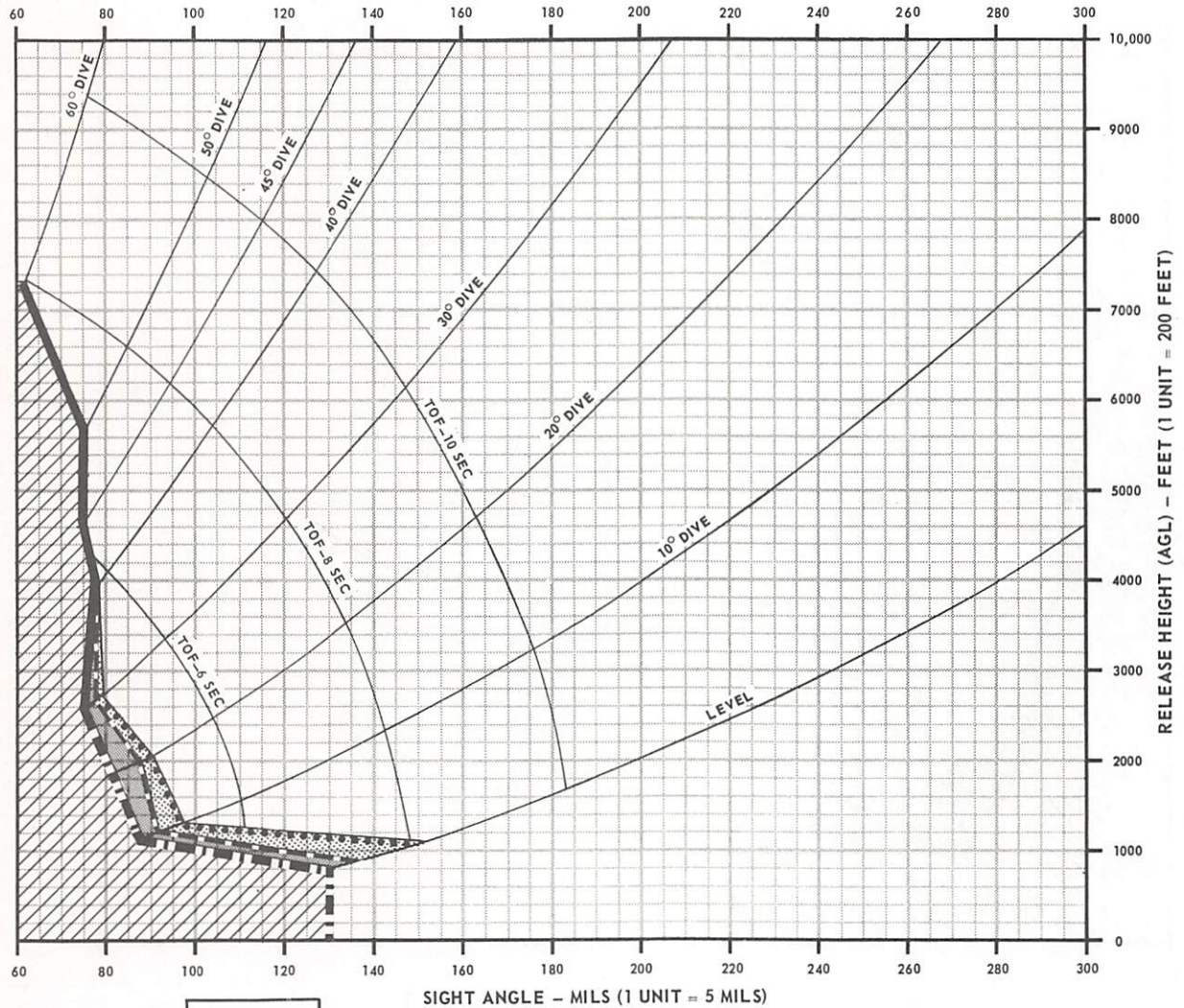
SIGHT ANGLE

MK 83 LDGP BOMB, MK 40 DESTRUCTOR AND MK 88 PRACTICE-CONICAL FIN

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0	1100	151	1100	900	136	900	825	131	825
10	1300	97	900	1225	93	825	1125	88	725
20	2100	91	1000	1975	87	875	1850	83	750
30	2700	79	650	2675	79	625	2550	76	500
FRAG / TERRAIN 40	3975	78	700	3975	78	700	3975	78	700
45	4675	76	700	4675	76	700	4675	76	700
50	5725	76	1000	5725	76	1000	5725	76	1000
60	7350	62	1000	7350	62	1000	7350	62	1000

NEW NEW NEW

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
*MK 83 LDGP: 985 LBS/4.8 FPS
MK 88 PRACTICE: 750 LBS/5.2 FPS
MK 40 DESTRUCTOR: 985 LBS/4.8 FPS

*USED IN SIGHT ANGLE COMPUTATIONS.

UNCLASSIFIED

FDB-1T-(175-8)

Figure 2-81 (U) (Sheet 7 of 8)

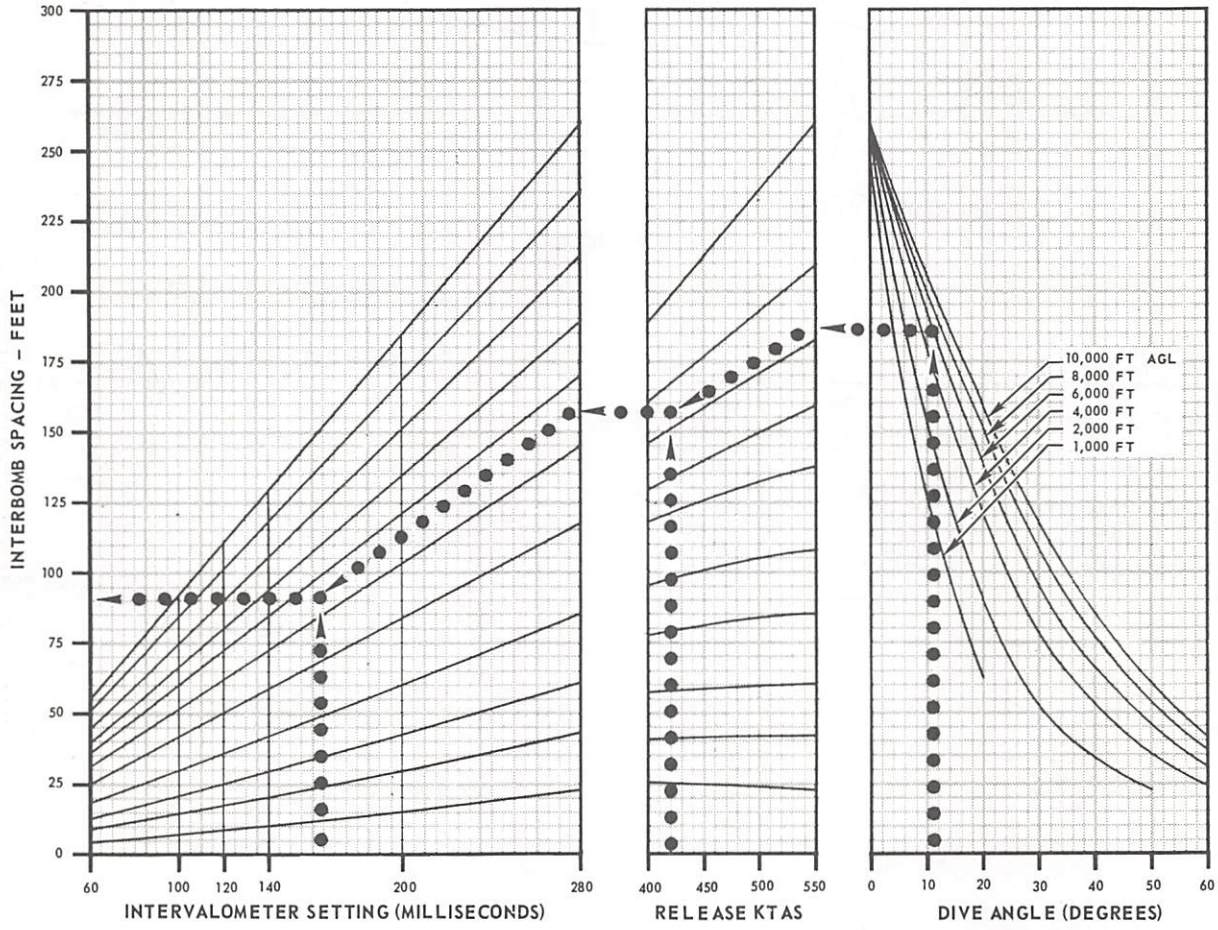
BOMB SPACING

MK 83 LDGP, MK 40 DESTRUCTOR AND MK 88 PRACTICE-CONICAL FIN

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
MER–TER EJECTION VELOCITY 4.8 FT/SEC)

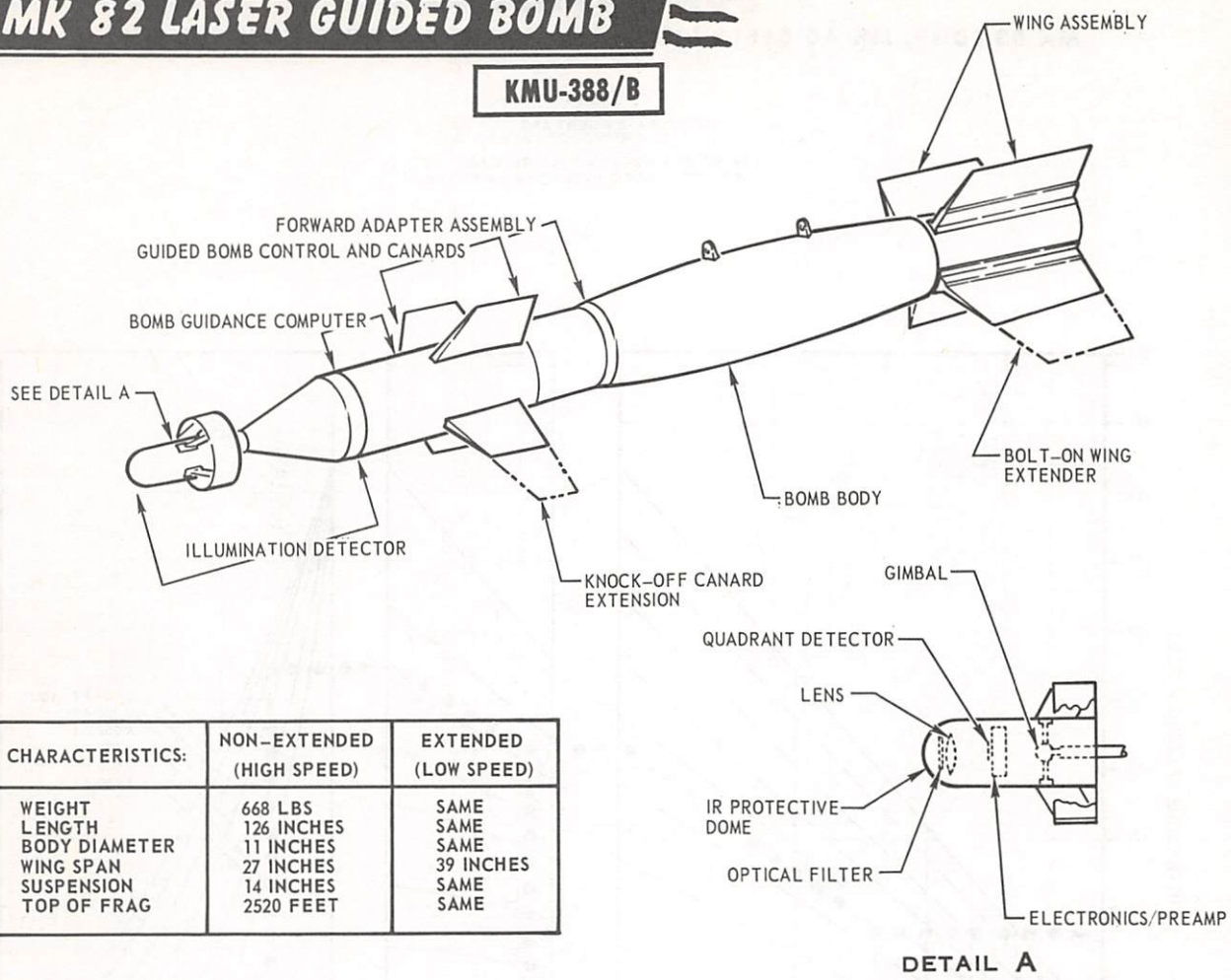


UNCLASSIFIED
FDB–1T–(175–9)

Figure 2-81 (U) (Sheet 8 of 8)

MK 82 LASER GUIDED BOMB

KMU-388/B



CHARACTERISTICS:	NON-EXTENDED (HIGH SPEED)	EXTENDED (LOW SPEED)
WEIGHT	668 LBS	SAME
LENGTH	126 INCHES	SAME
BODY DIAMETER	11 INCHES	SAME
WING SPAN	27 INCHES	39 INCHES
SUSPENSION	14 INCHES	SAME
TOP OF FRAG	2520 FEET	SAME

DESCRIPTION

Refer To Section Section II, Part 2, Laser Mission

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations . . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration and Suspension Equipment . . NAVAIR 01-245FDB-75
5. Current AAB's.

CONFIDENTIAL

FDB-1T-(240-1)

Figure 2-82 (C) (Sheet 1 of 4)

MAXIMUM FRAGMENT ENVELOPE
MK 82 BOMB

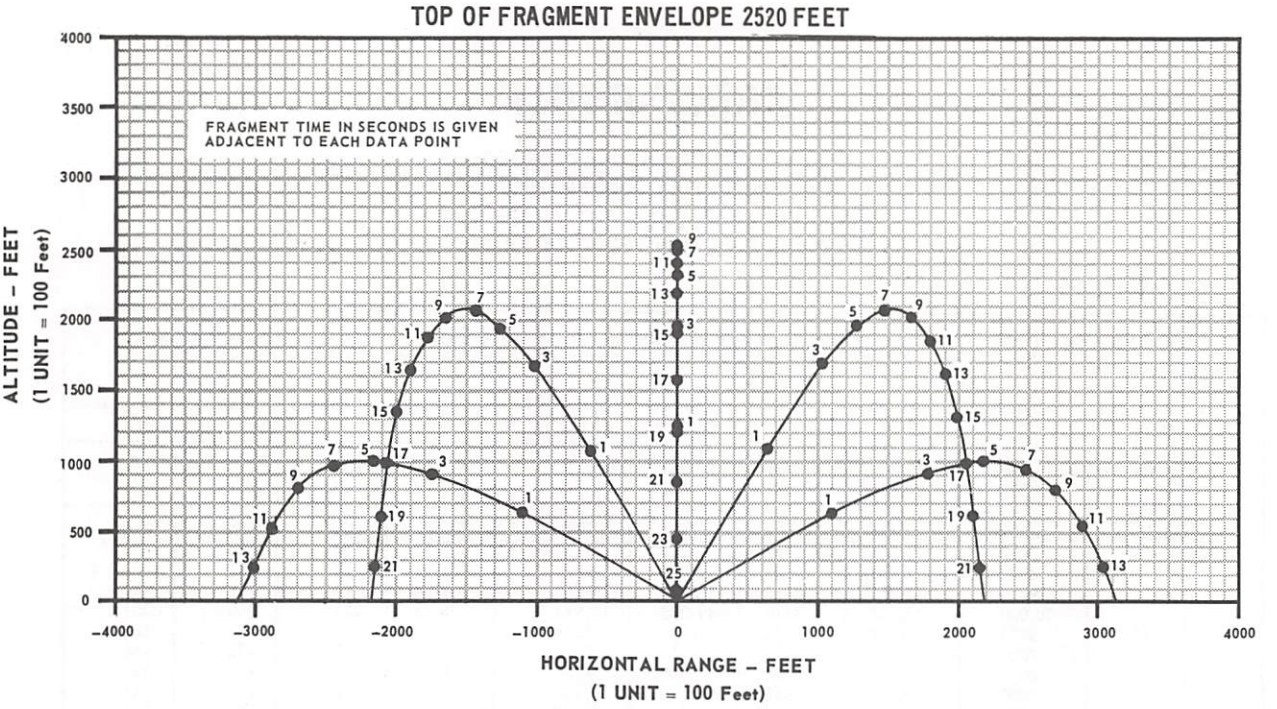


Figure 2-82 (U) (Sheet 2 of 4)

MK 82 LASER GUIDED BOMB-CONTINUED

SIGHT ANGLE

MARK 82 LGB NON-EXTENDED
FIN DAMPER CONSTANT 8.0
MAX ALLOWABLE ACQ SLANT RANGE 12000 FT
MER/TER EJECTION VELOCITY 6.0 FT/SEC

RELEASE CONDITIONS			HORIZONTAL RANGE FOR ENVELOPE PARAMETERS					SIGHT ANGLE (MILS)		
Dive Angle (DEG)	Airspeed (KTAS)	Altitude (FT)	Max Pt (FT)	Min Pt (FT)	Centroid (FT)	Optimum Pt (FT)	Ballistic	Centroid	Optimum	Ballistic
0°	450	15,000	22,312	17,739	20,051	19,331	18,611	683	701	719
	500	15,000	24,655	19,851	22,253	21,522	20,792	622	638	654
30°	450	6000	9131	6104	7620	7210	6801	160	188	217
		7000	11,644	6869	9232	8433	7634	144	188	238
		8000	12,527	7529	10,072	9213	8354	168	211	260
		9000	13,226	8143	10,729	9862	8996	196	238	284
		10,000	13,767	8719	11,335	10,514	9673	222	260	301
	500	6000	9689	6404	7995	7585	7175	131	157	185
		7000	12,035	7255	9700	8945	8190	113	152	196
		8000	13,000	7960	10,580	9755	8930	137	176	220
		9000	13,818	8660	11,316	10,453	9589	162	201	244
		10,000	14,620	9365	12,020	11,142	10,265	185	223	264
	550	6000	9997	6615	8245	7870	7495	110	133	156
		7000	12,635	7580	10,115	9373	8630	88	124	164
		8000	13,560	8310	11,010	10,213	9415	112	148	188
		9000	14,372	8990	11,740	10,933	10,125	138	173	211
		10,000	15,221	9765	12,560	11,730	10,900	158	191	228
45°	450	8000	8300	4926	6575	6180	5786	110	141	172
		9000	9090	5362	7224	6752	6281	123	156	190
		10,000	9856	5797	7841	7303	6766	135	170	206
		11,000	10,632	6237	8448	7844	7241	147	183	220
		12,000	11,423	6685	9054	8390	7726	157	193	231
	500	8000	8634	5151	6795	6420	6046	88	116	145
		9000	9427	5586	7461	7023	6586	101	131	162
		10,000	10,207	6026	8123	7619	7116	112	143	176
		11,000	10,985	6463	8755	8197	7640	123	155	188
		12,000	11,779	6899	9400	8787	8175	132	164	198
	550	8000	8800	5326	6959	6622	6286	71	96	121
		9000	9624	5791	7663	7262	6862	83	109	137
		10,000	10,477	6260	8350	7888	7462	94	122	151
		11,000	11,318	6720	9052	8518	7984	102	131	163
		12,000	12,221	7179	9766	9162	8559	108	139	172

NOTE: Sight angle based on aircraft gross weight of 42,000 pounds.

CONFIDENTIAL

FDB-IT-(240-3)

Figure 2-82 (C) (Sheet 3 of 4)

MK 82 LASER GUIDED BOMB-CONTINUED

SIGHT ANGLE

MARK 82 LGB EXTENDED
FIN DAMPER CONSTANT 8.0
MAX ALLOWABLE ACQ SLANT RANGE 12000 FT
MER/TER EJECTION VELOCITY 6.0 FT/SEC

RELEASE CONDITIONS			HORIZONTAL RANGE FOR ENVELOPE PARAMETERS					SIGHT ANGLE (MILS)		
Dive Angle (DEG)	Airspeed (KTAS)	Altitude (FT)	Max Pt (FT)	Min Pt (FT)	Centroid (FT)	Optimum Pt (FT)	Ballistic (FT)	Centroid	Optimum	Ballistic
0°	450	15,000	24,100	18,500	21,300	20,400	19,500	654	675	697
	500	15,000	26,500	20,600	23,550	22,675	21,800	596	613	632
30°	450	5000	9190	5300	7200	6600	6000	99	142	188
		6000	10,900	6200	8385	7642	6900	114	159	210
		7000	12,105	7000	9360	8530	7700	138	186	233
		8000	13,150	7600	10,255	9327	8400	159	205	257
		9000	14,090	8300	11,170	10,135	9100	177	225	278
	500	5000	9410	5500	7455	6827	6200	77	119	166
		6000	11,350	6400	8875	8040	7200	82	128	183
		7000	12,465	7200	9830	8965	8100	107	151	201
		8000	13,580	8000	10,790	9840	8900	127	172	222
		9000	14,600	8800	11,700	10,700	9700	146	190	238
	550	5000	9635	5590	7615	7057	6500	61	97	137
		6000	11,600	6550	9060	8280	7500	66	108	156
		7000	13,020	7405	10,145	9273	8400	86	129	177
		8000	14,095	8240	11,120	10,210	9300	107	148	194
		9000	15,085	9090	12,090	11,145	10,200	124	164	207
45°	450	6000	7020	4000	5510	5105	4700	53	91	132
		7000	8450	4500	6475	5837	5200	50	101	158
		8000	9540	4900	7220	6510	5800	64	115	171
		9000	10,420	5400	7910	7105	6300	78	131	189
		10,000	11,280	5800	8540	7670	6800	94	146	203
	500	6000	7135	4200	5667	5234	4800	35	74	118
		7000	8830	4600	6715	6057	5400	28	79	135
		8000	9980	5100	7540	6770	6000	37	90	149
		9000	10,835	5600	8217	7409	6600	53	105	161
		10,000	11,670	6100	8885	7992	7100	68	120	177
	550	6000	7200	4200	5700	5350	5000	26	57	92
		7000	8950	5600	6775	6187	5600	17	63	112
		8000	10,200	5200	7700	6950	6200	21	72	128
		9000	11,080	5700	8390	7595	6800	38	87	141
		10,000	11,960	6200	9080	8240	7400	52	100	152

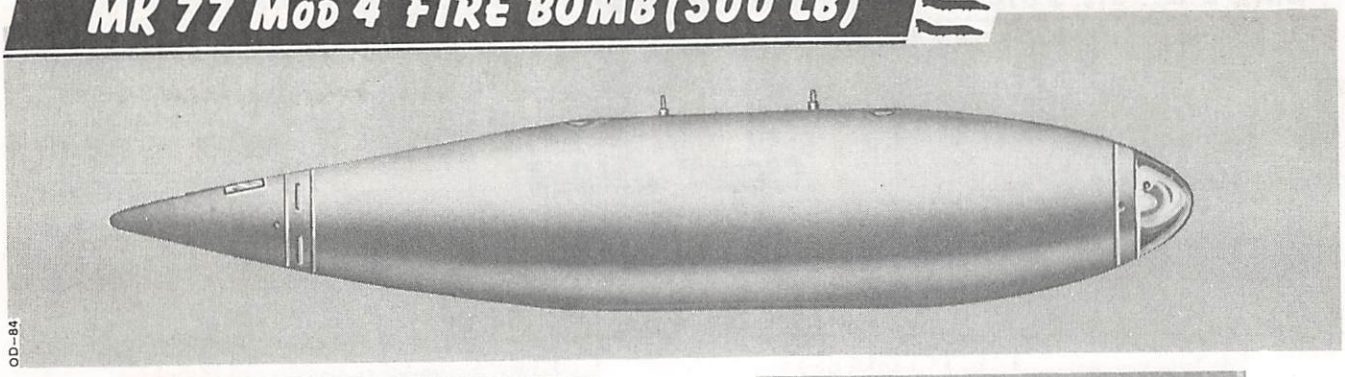
NOTE: Sight angle based on aircraft gross weight of 42,000 pounds.

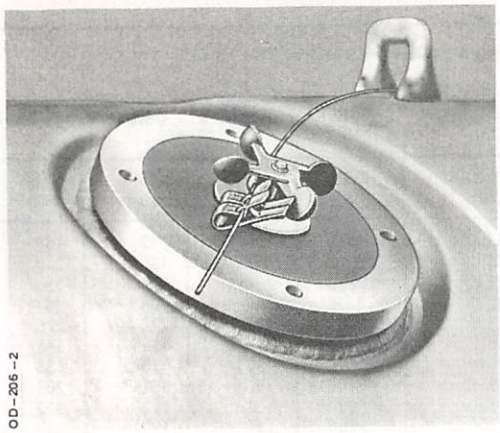
CONFIDENTIAL

FDB-1T-(240-4)

Figure 2-82 (C) (Sheet 4 of 4)

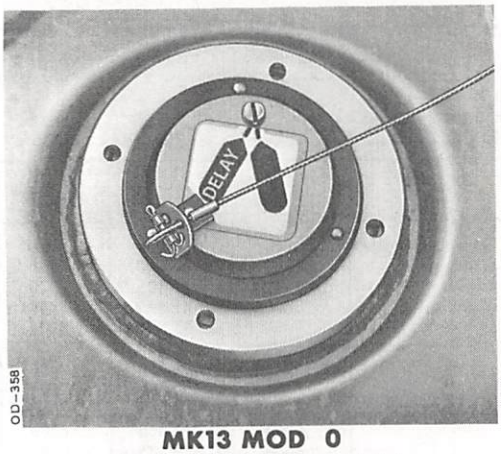
MK 77 MOD 4 FIRE BOMB (500 LB)





M918 FUZE

OR



MK13 MOD 0
FIRE BOMB INITIATOR

PAINTING AND MARKING
PURPLE BANDS ON ALUMINUM BODY.
IDENTIFYING NOMENCLATURE
STENCILED IN RED ON BOMB BODY.

LENGTH	9 FEET 6 INCHES
DIAMETER	18.73 INCHES
FILLER	75 GALLONS
WEIGHT (LOADED)	520 POUNDS
SUSPENSION	14 INCHES
APPROX TOP OF FIREBALL	250 FEET

DESCRIPTION:

The 500-pound fire bomb, MK 77 Mod 4, is a 75-gallon capacity, thin skin version of the MK 77 Mod 0 750-pound fire bomb. Two fill holes are on the top surface. Once a bomb is filled it cannot be disassembled; it must be used or jettisoned.

The Mod 4 will use only M918 fuze or the MK 13 Mod 0 Fire Bomb Initiator.

REFERENCE:

1. MIXING GEL & FILLING . . . . . NAVWEPS OP 2183
2. Bomb Assembly . . . . . NAVAIR 11-5A-17
3. External Store Limitations . . . . . Appendix A
4. Fuzing and Fuze Limitations. . . . . Section II, Part 1
5. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
6. Current AAB's.
7. Stores Reliability Card. . . . . (MK 77 Mod 4) NAVAIR 01-245FD-75-4.2

UNCLASSIFIED

FDB-1T-(176-1)

Figure 2-83 (U) (Sheet 1 of 5)

This page is UNCLASSIFIED

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 77 MOD 4 FIRE BOMB

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: +LONG, −SHORT)									RELATIVE WIND −10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	−10 KTS	+100 FT	−100 FT	+1 DEG	−1 DEG	+1 MIL	−1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	100	450	32	−32	−981	−	145	−389	24.9	−25.7	1.6	40	1.6	42	26.1
	300	450	49	−49	−531	443	180	−303	23.0	−23.4	2.6	77	3.3	75	28.9
	500	450	57	−58	−401	363	188	−274	21.5	−21.8	3.3	102	4.7	102	30.8
10°	600	450	23	−23	−122	98	40	−54	8.7	−8.7	2.3	31	7.2	63	27.5
	800	500	27	−28	−128	109	55	−74	10.7	−10.8	2.9	77	7.2	76	26.3
20°	1500	450	26	−27	−59	54	33	−39	7.1	−7.1	3.3	95	13.4	96	29.1
	1500	500	23	−23	−58	52	33	−39	7.6	−7.6	3.4	90	11.9	91	26.8

UNCLASSIFIED

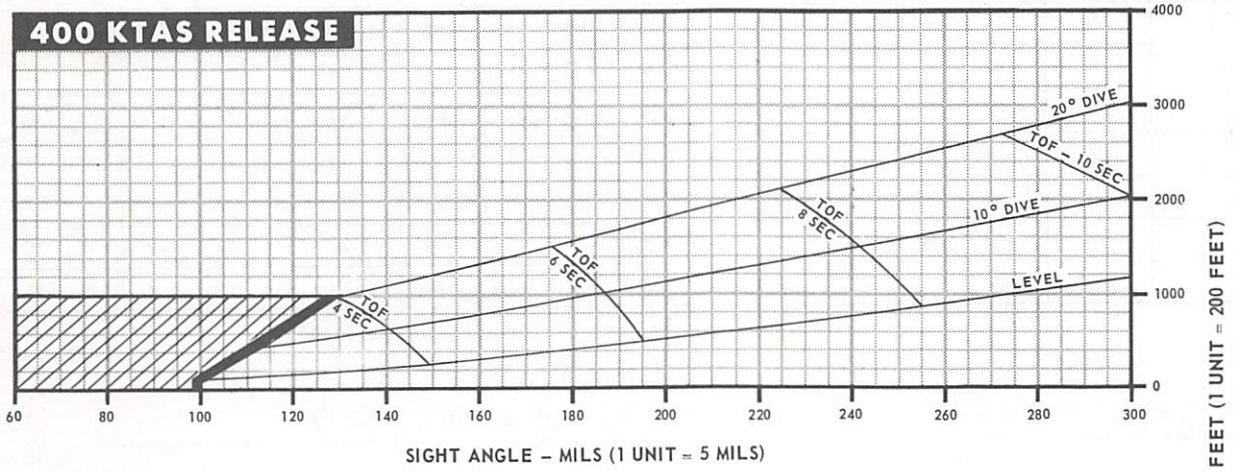
FDB−1T−(176−2)

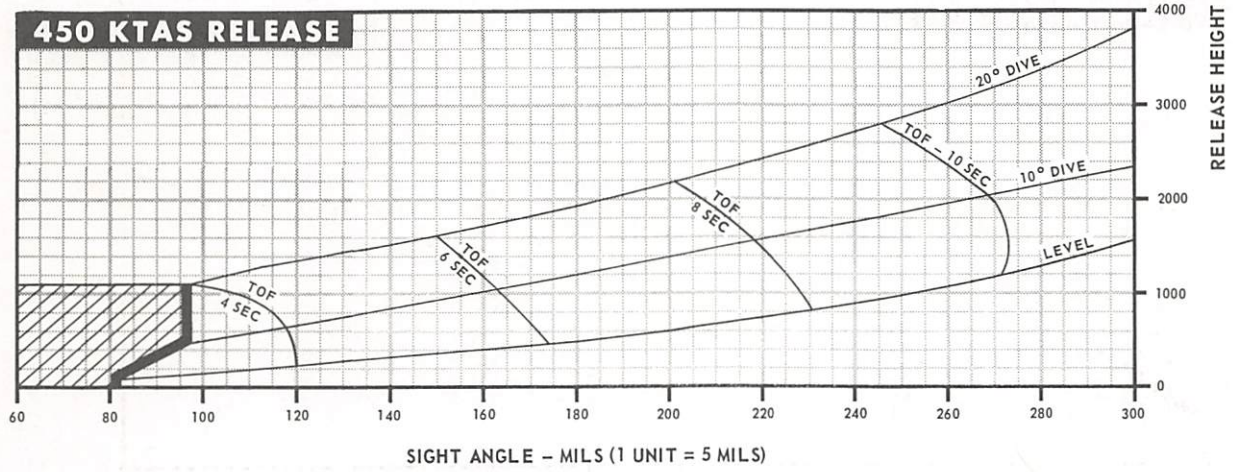
Figure 2-83 (U) (Sheet 2 of 5)

SIGHT ANGLE
MK 77 MOD 4 FIRE BOMB

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE FOR ON TARGET, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALAX CORRECTION AS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).





WARNING

400 KTAS

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	101	100
10	475	116	200
20	1000	131	300

450 KTAS

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	82	100
10	525	99	200
20	1125	116	300

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 77 FIRE BOMB: 520 LBS/6.0 FPS

NEW NEW

UNCLASSIFIED

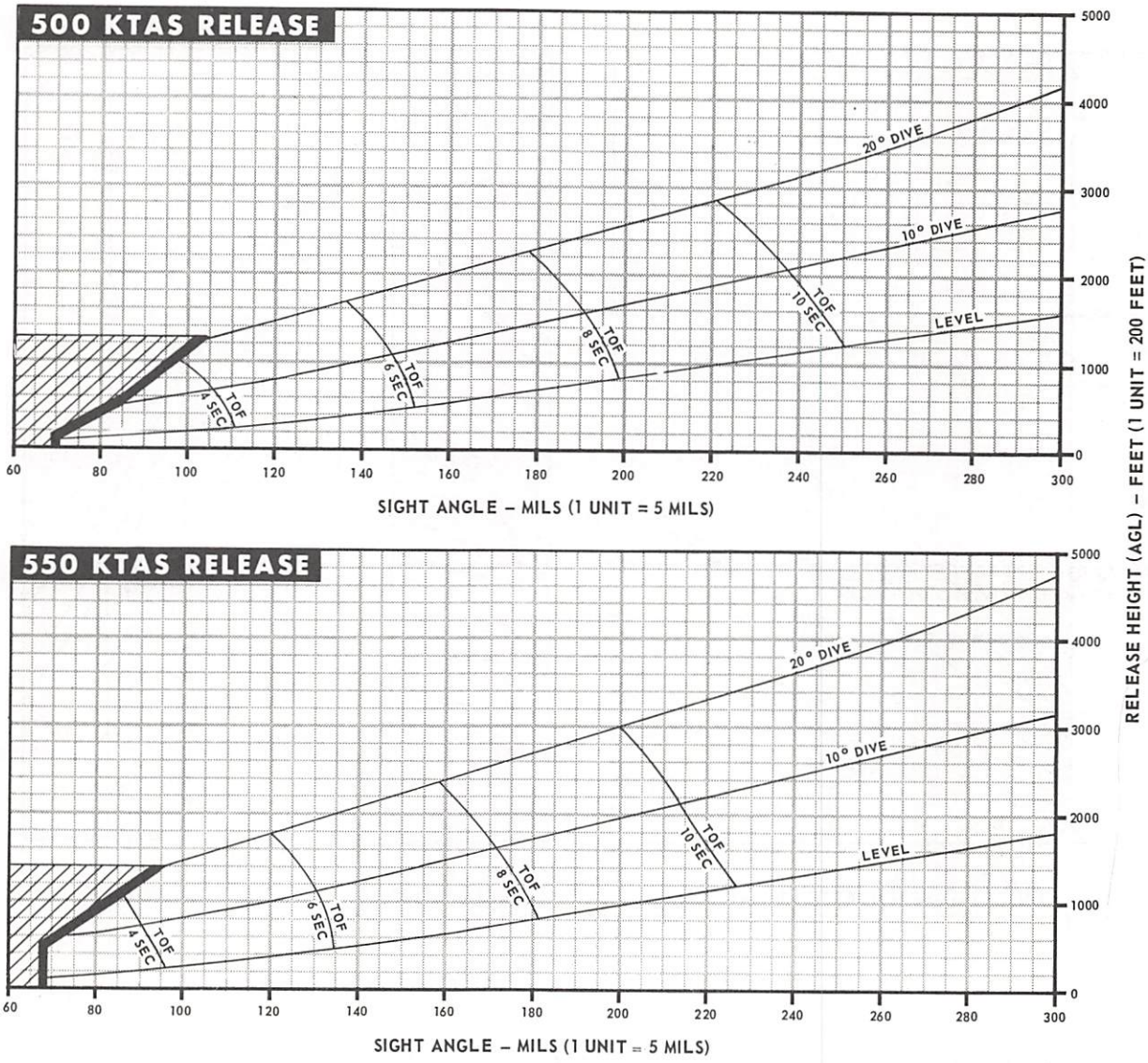
FDB-1T-(176-3)

Figure 2-83 (U) (Sheet 3 of 5)

SIGHT ANGLE
MK 77 MOD 4 FIRE BOMB

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT SINGLE BOMB RELEASE FOR ON TARGET, STANDARD DAY ATMOSPHERE 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



500 KTAS | **WARNING** | **550 KTAS**

NEW NEW

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	71	100
10	550	85	200
20	1250	104	300

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	58	100
10	600	74	200
20	1400	96	300

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 77 FIRE BOMB: 520 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(176–4)

Figure 2-83 (U) (Sheet 4 of 5)

BOMB SPACING
MK 77 FIRE BOMB

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB
(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 6.0 FT/SEC)

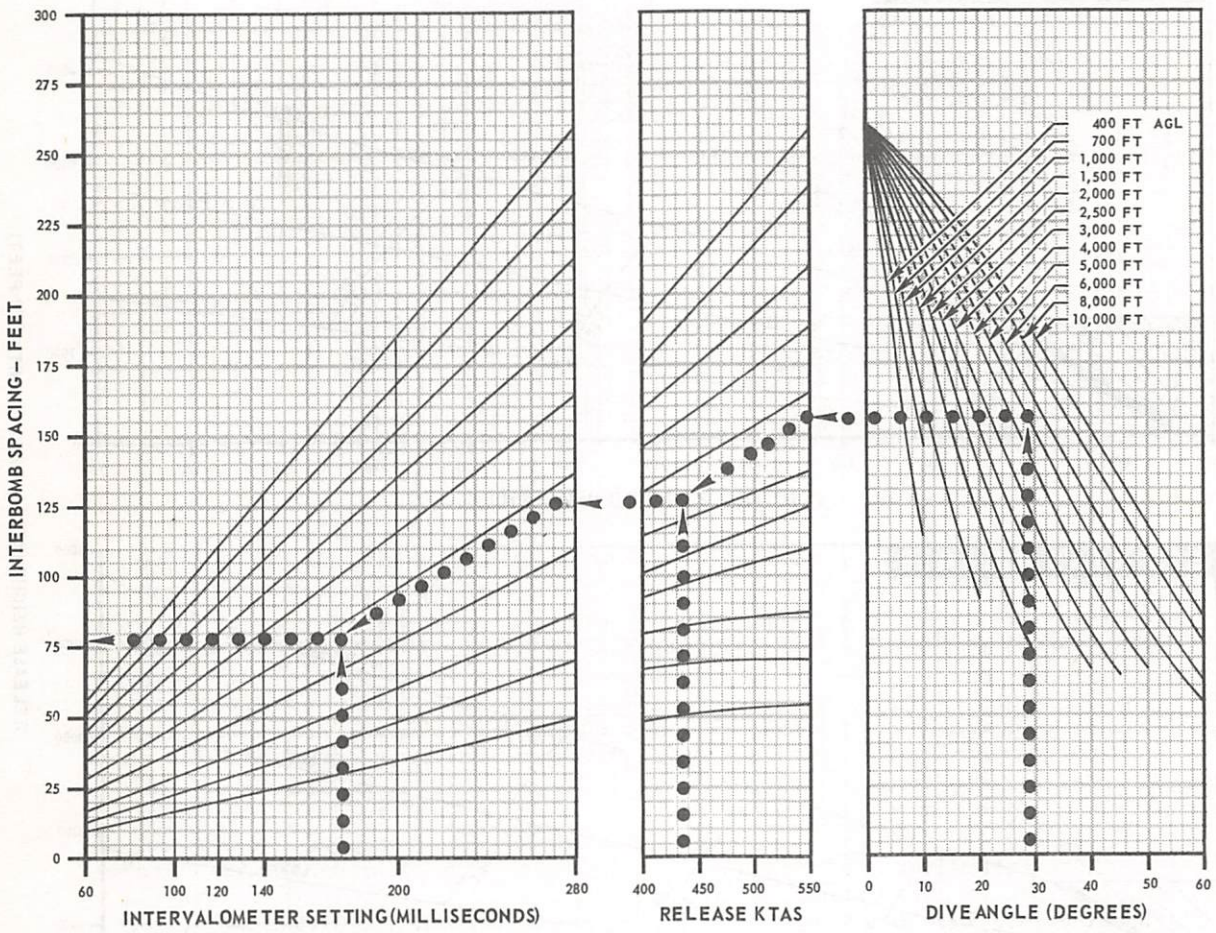
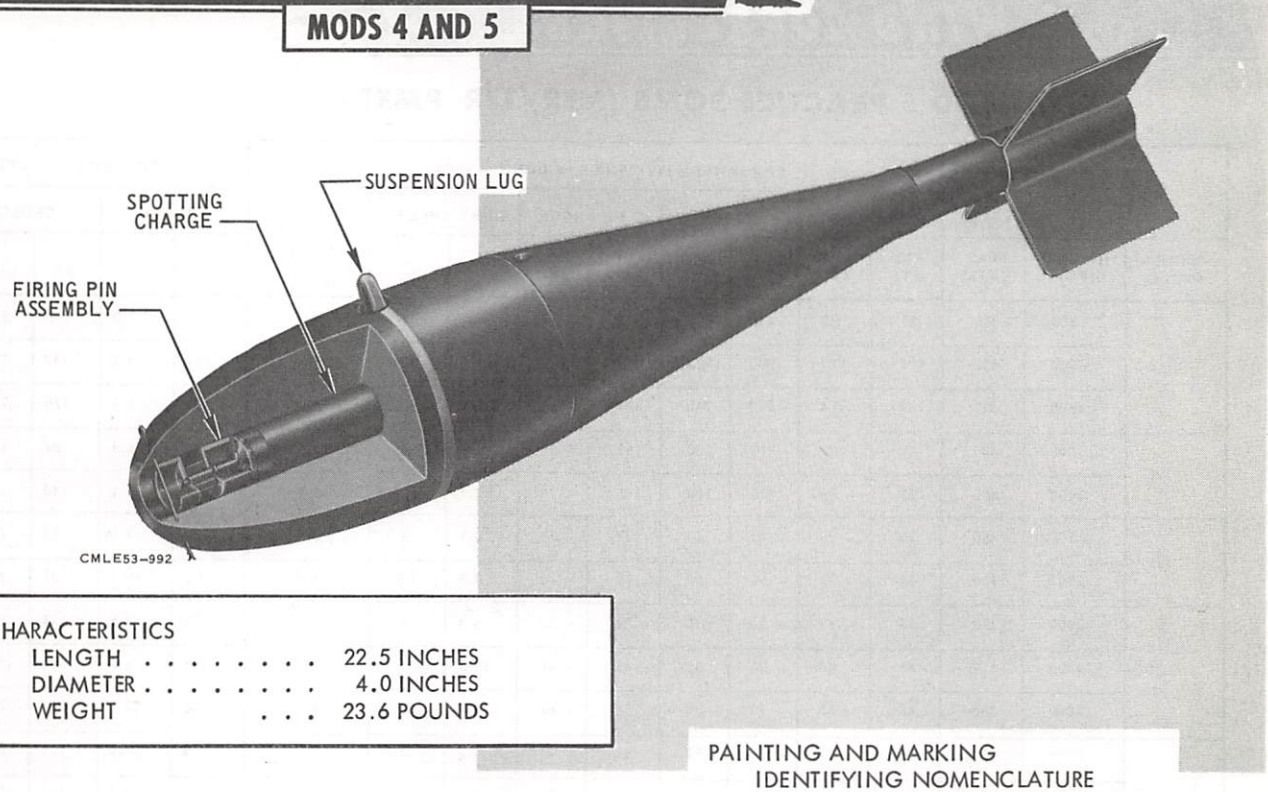


Figure 2-83 (U) (Sheet 5 of 5)

MK 76 PRACTICE BOMB (25 LB)

MODS 4 AND 5



CHARACTERISTICS

LENGTH	22.5 INCHES
DIAMETER	4.0 INCHES
WEIGHT	23.6 POUNDS

PAINTING AND MARKING
IDENTIFYING NOMENCLATURE STENCILED IN WHITE ON BLUE BODY. (EARLY BOMB, WHITE LETTERING ON BLACK BODY).

DESCRIPTION

The MK 76 Mod 4 and Mod 5 practice bomb has a teardrop shaped cast iron body, with four fins welded to the aft center tube. Upon contact with the ground, the firing pin assembly fires the signal which is seated in the base of the body section. Smoke produced from the MK 4 Mod 3 spotting charge is discharged rearward through the tube of the fin assembly sufficient for bomb "spotting" purposes. All the delivery data is prepared for the Mod 4 and 5 practice bomb with suspension lug installed. The bomb is carried and released from the PMBR, MERs and TERs.

REFERENCES

1. Bomb Assembly . . . . . .NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . .Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-16.1

UNCLASSIFIED

FDB-1T-(177-1)

Figure 2-84 (U) (Sheet 1 of 7)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 76-MOD 5 PRACTICE BOMB (MER/TER PMBR)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT Slant Range 1000 Ft	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL		FT	MILS	FT	MILS
0°	500	450	83	- 83	-440	400	241	-391	31.4	-34.1	4.0	98	3.0	96	23.9
	1000	450	112	-113	-300	290	260	-362	31.1	-32.8	5.6	137	4.3	137	24.4
	1500	450	133	-134	-250	240	271	-353	30.8	-32.2	6.9	170	5.4	170	24.7
10°	1000	450	41	- 42	-110	100	61	- 80	12.9	-13.4	3.6	84	6.4	84	23.3
	2000	450	77	- 78	-100	100	106	-129	17.1	-17.6	5.9	141	8.1	140	23.7
20°	1500	450	25	- 26	- 40	40	27	- 33	8.1	- 8.3	3.5	80	9.8	80	22.9
	2000	450	36	- 37	- 50	50	39	- 46	9.8	-10.0	4.4	102	10.3	101	23.0
30°	3000	450	31	- 32	- 30	30	29	- 33	8.3	- 8.4	5.0	113	13.5	113	22.6
	4000	450	45	- 46	- 30	30	43	- 48	10.3	-10.4	6.4	145	14.0	145	22.6
	5000	500	48	- 50	- 30	30	56	- 62	12.6	-12.8	8.0	166	13.1	167	20.9
45°	4000	450	20	- 21	- 10	10	19	- 21	6.7	- 6.8	5.2	115	17.0	114	22.0
	5000	450	28	- 29	- 20	10	27	- 29	8.1	- 8.2	6.4	140	17.2	140	21.9
	6000	500	29	- 30	- 20	20	33	- 36	9.7	- 9.8	7.7	155	15.9	156	20.3
60°	5500	450	16	- 16	- 10	10	19	- 20	6.8	- 6.8	6.1	132	19.4	131	21.5
	7000	500	18	- 18	- 10	10	25	- 27	8.6	- 8.6	7.8	154	17.9	155	19.9

UNCLASSIFIED

FDB-1T-(177-2)

Figure 2-84 (U) (Sheet 2 of 7)

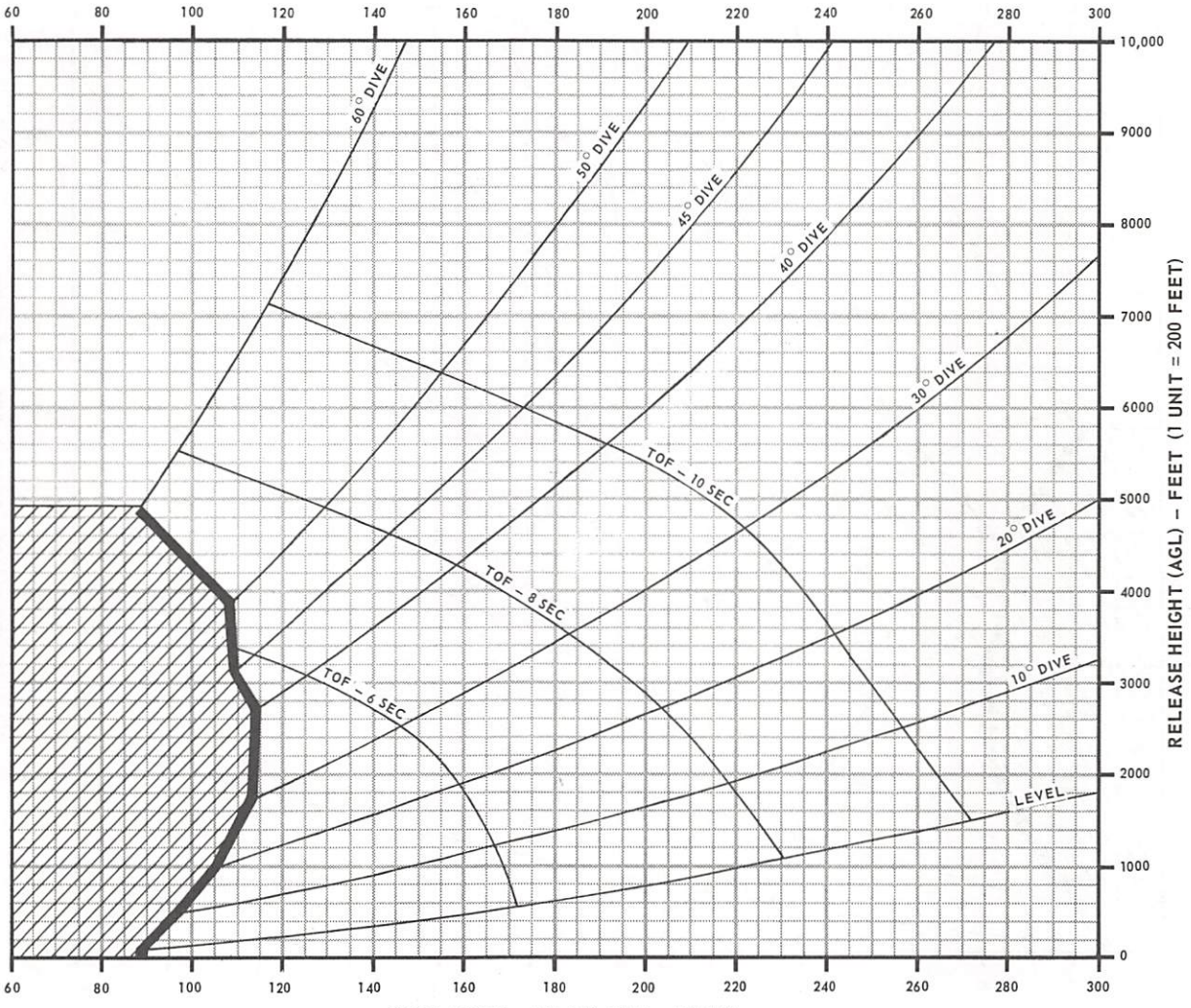
SIGHT ANGLE

MK 76 MOD 5 PRACTICE BOMB (WITH LUG)

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV. ERY ALT (FT)
0	100	90	100
10	475	98	200
20	1000	106	300
30	1775	114	500
40	2725	115	700
45	3150	110	700
50	3925	108	1000
60	4950	88	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: MK 76 MOD 5 PRACTICE: 23.6 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(177-3)

Figure 2-84 (U) (Sheet 3 of 7)

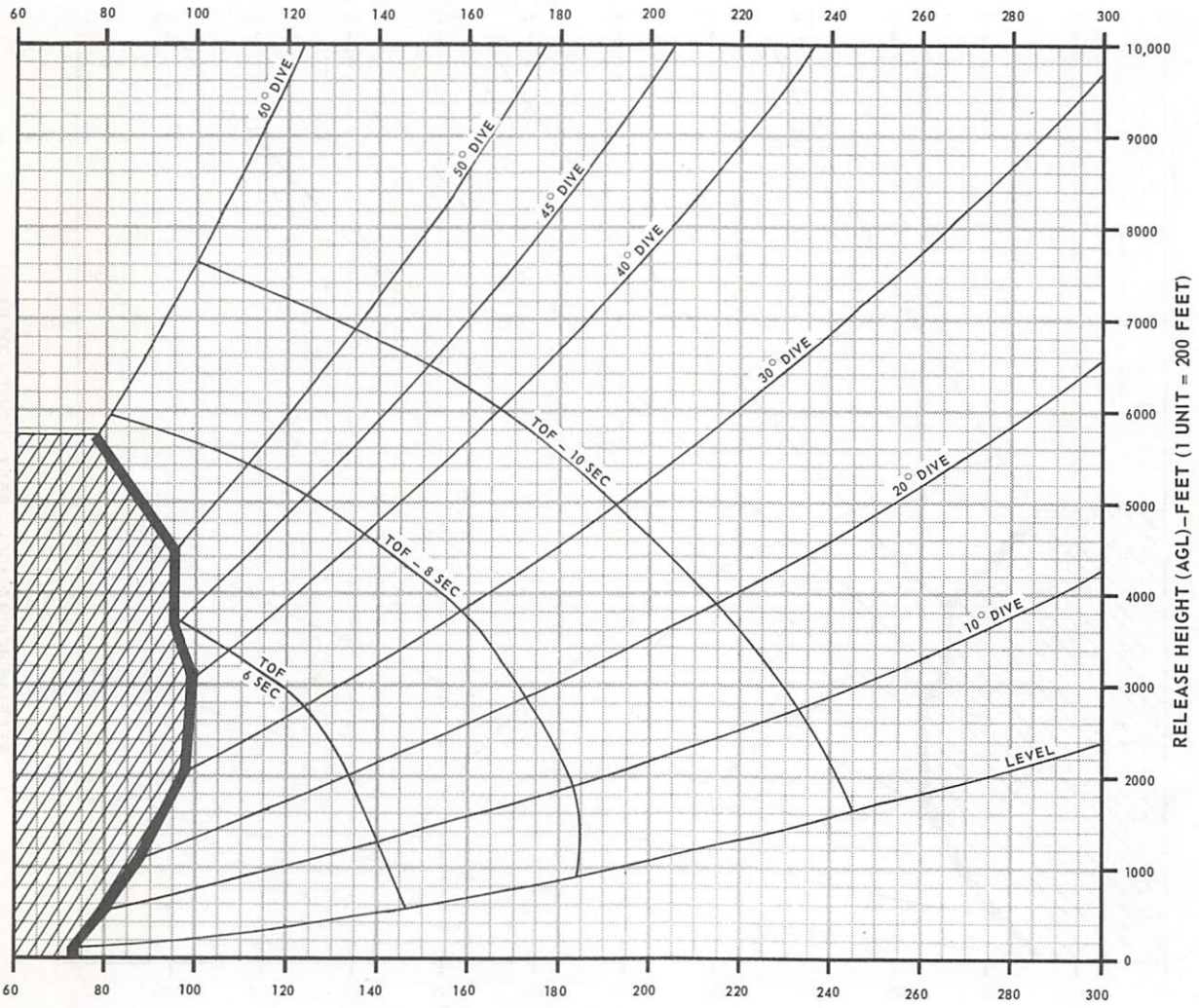
SIGHT ANGLE

MK 76 MOD 5 PRACTICE BOMB (WITH LUG)

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	74	100
10	525	81	200
20	1125	89	300
30	2025	99	500
40	3125	100	700
45	3650	96	700
50	4525	96	1000
60	5750	78	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 76 MOD 5 PRACTICE: 23.6 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(177-4)

Figure 2-84 (U) (Sheet 4 of 7)

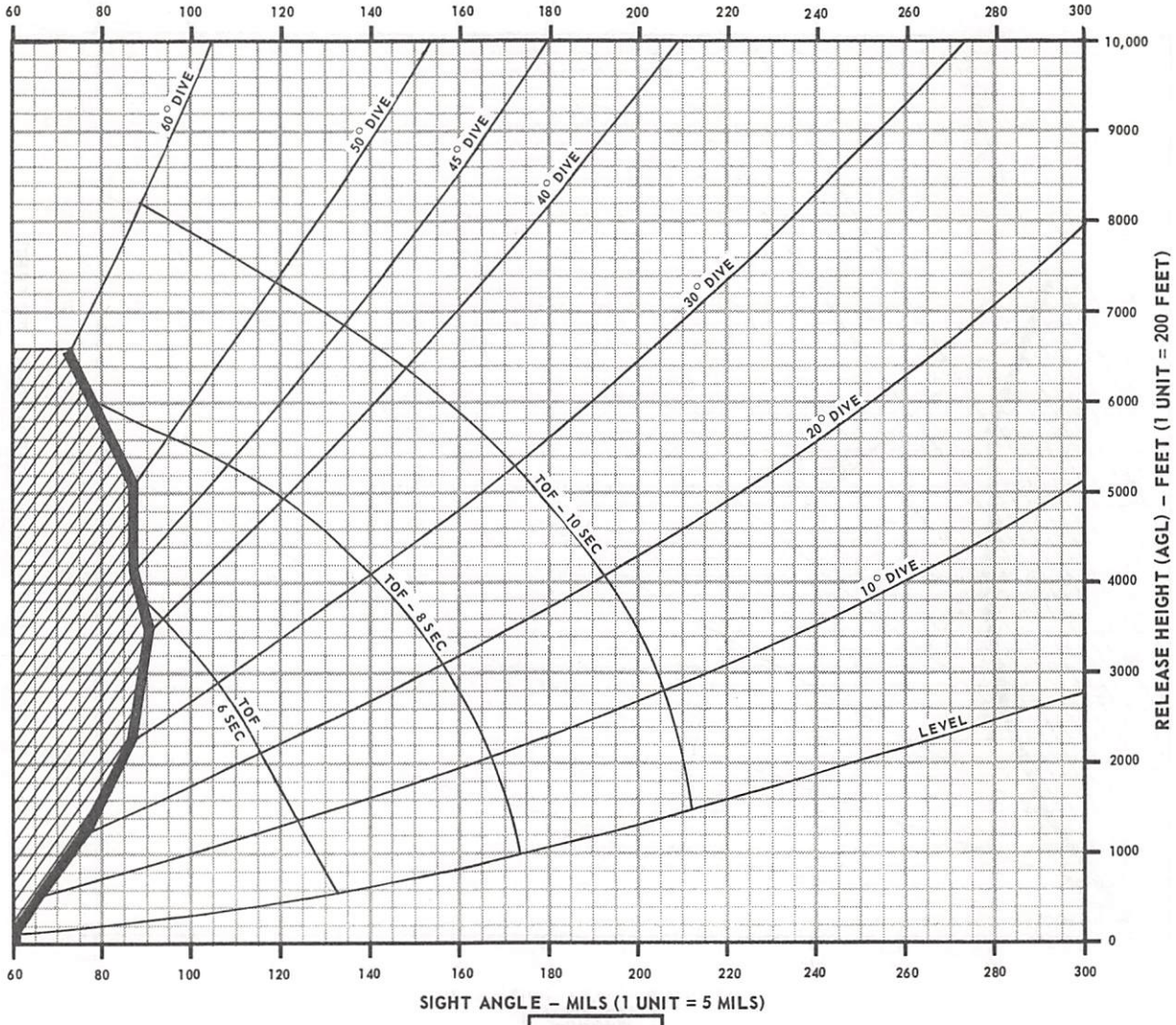
SIGHT ANGLE

MK 76 MOD 5 PRACTICE BOMB (WITH LUG)

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	61	100
10	550	67	200
20	1250	78	300
30	2300	87	500
40	3550	92	700
45	4175	88	700
50	5125	88	1000
60	6600	73	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 76 MOD 5 PRACTICE: 23.6 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(177-5)

Figure 2-84 (U) (Sheet 5 of 7)

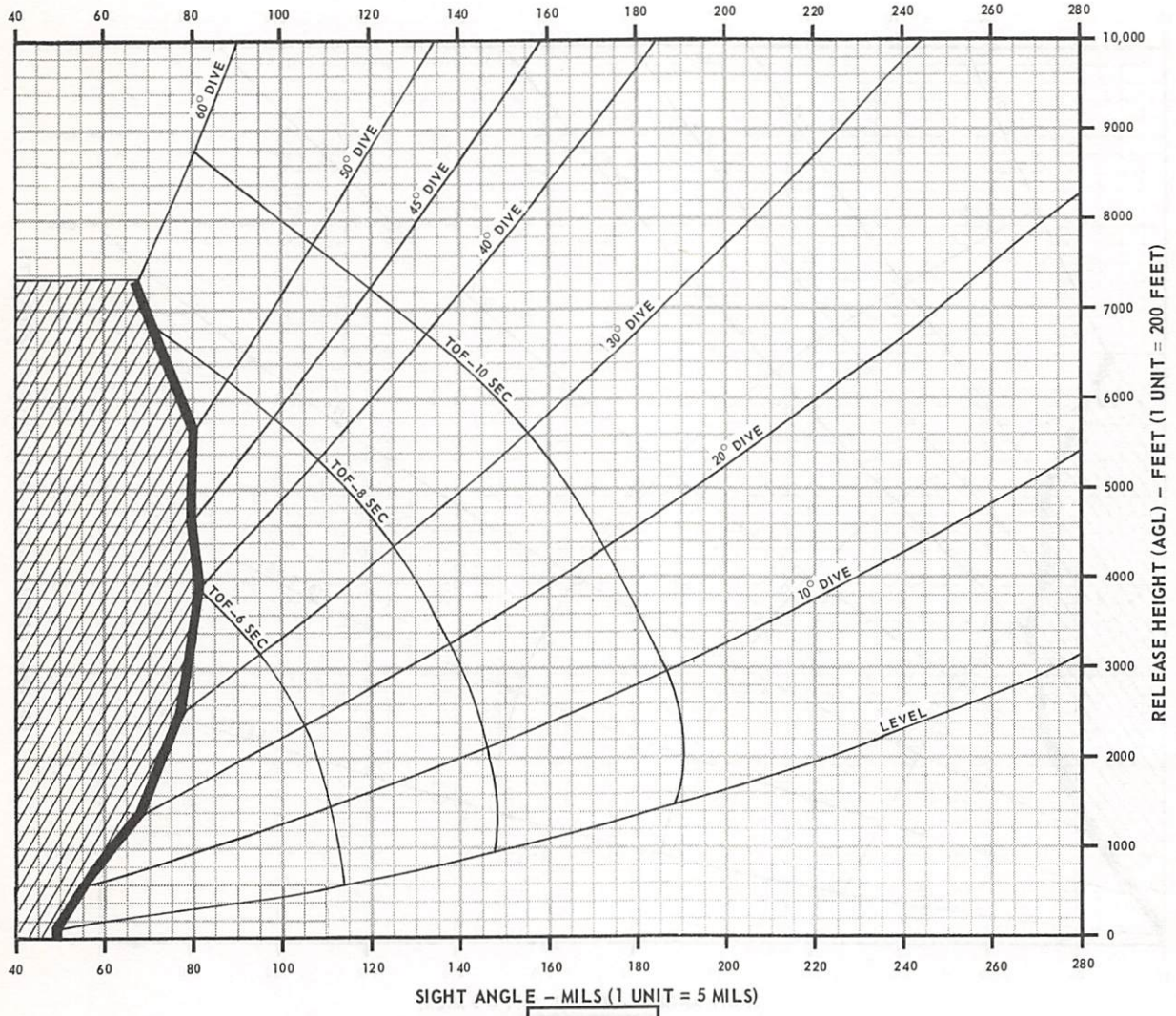
SIGHT ANGLE

MK 76 MOD 5 PRACTICE BOMB (WITH LUG)

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	50	100
10	600	56	200
20	1400	69	300
30	2550	78	500
40	3975	82	700
45	4675	81	700
50	5725	82	1000
60	7350	68	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
MK 76 MOD 5 PRACTICE: 23.6 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(177-6)

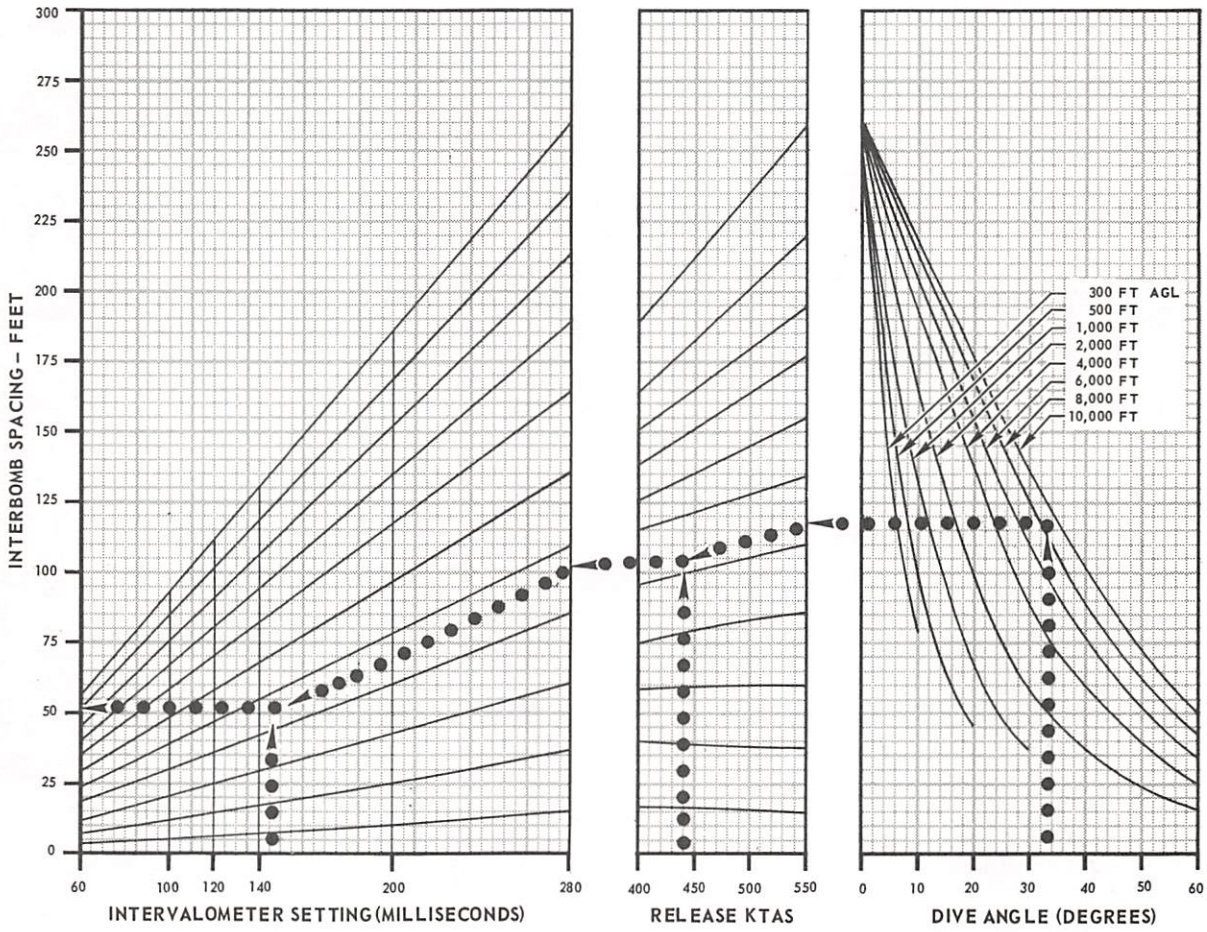
Figure 2-84 (U) (Sheet 6 of 7)

BOMB SPACING
MK76 MOD 5 PRACTICE BOMB (WITH LUG)

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
PMBR EJECTOR VELOCITY 0.0 FT/SEC)



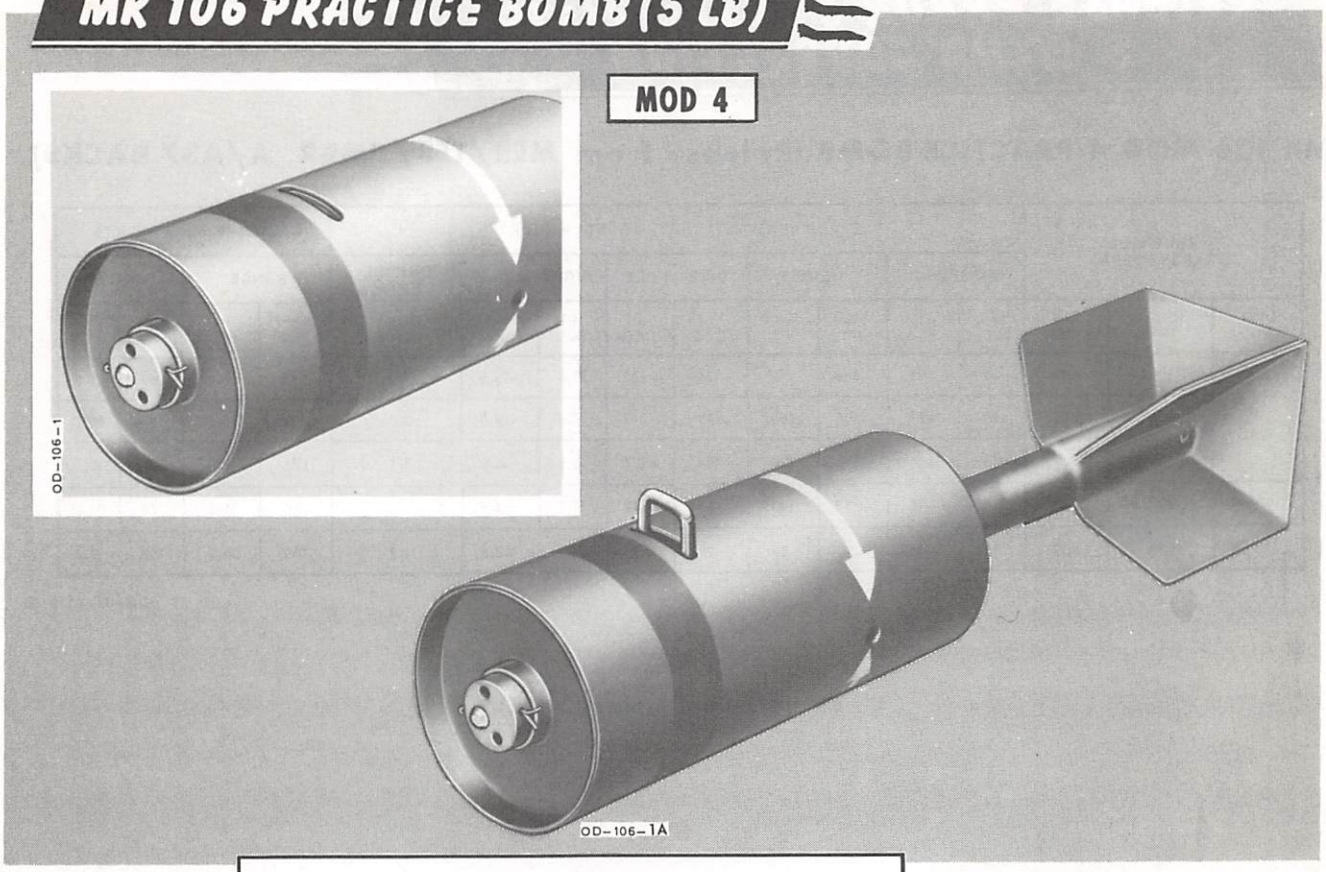
UNCLASSIFIED

FDB-1T-(177-7)

Figure 2-84 (U) (Sheet 7 of 7)

MK 106 PRACTICE BOMB (5 LB)

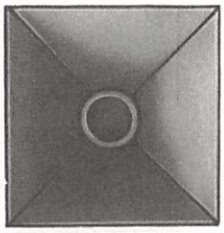
MOD 4



CHARACTERISTICS:

LENGTH	18.75 INCHES
DIAMETER	3.87 INCHES
WEIGHT	4.9 POUNDS

PAINTING AND MARKING
ORANGE BODY WITH WHITE BAND.



AFT VIEW

DESCRIPTION

The high drag MK 106 Mod 4 practice bomb is constructed of steel. The bomb is composed of an inner cylinder, an outer cylinder, and fin assembly. The bomb utilizes the MK 4 Mod 3 signal (spotting charge) installed into the inner cylinder. A box type fin assembly, consisting of four metal vanes welded together, is welded to the aft end of the inner cylinder.

The MK 106 Mod 4 has a bomb body assembly similiar to that of the Mod 0, 2 and 3 practice bombs. The Mod 4 box-type fin assembly has been retained, but redesigned for added strength to withstand the additional aerodynamic loads imposed by external carriage at increased aircraft speeds. Also, the four holes for attachment of drag tabs have been eliminated. The firing device is the same as that in the Mod 3.

The split-ring type suspension bracket furnished with the Mod 3 has been replaced with a permanent retractable lug which is compatible with PMBR, MERs and TERs.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
4. Current AAB's.
5. Stores Reliability Card. . . . . NAVAIR 01-245FD-75-16.1

UNCLASSIFIED

FDB-1T-(178-1)

Figure 2-85 (U) (Sheet 1 of 5)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 106 MOD 4 PRACTICE BOMB (Release from MER/TER/PMBR A/A37 RACKS)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: +LONG, − SHORT)									RELATIVE WIND −10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT Slant Range 1000 Ft	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	−10 KTS	+100 FT	−100 FT	+1 DEG	−1 DEG	+1 MIL	−1 MIL		FT	MILS	FT	MILS
0°	100	450	16	−17	−910	−	126	−242	13.8	−15.6	1.2	50	3.4	49	40.9
	500	450	20	−21	−300	280	95	−115	7.8	−8.1	2.0	120	15.1	120	60.2
	500	500	16	−16	−310	290	104	−127	8.5	−8.8	2.1	121	14.0	122	58.1
10°	500	400	16	−16	−170	140	40	−49	4.7	−4.8	1.5	80	16.8	78	51.8
20°	1000	400	16	−16	−90	80	29	−33	3.7	−3.6	1.9	109	30.2	108	57.1

UNCLASSIFIED

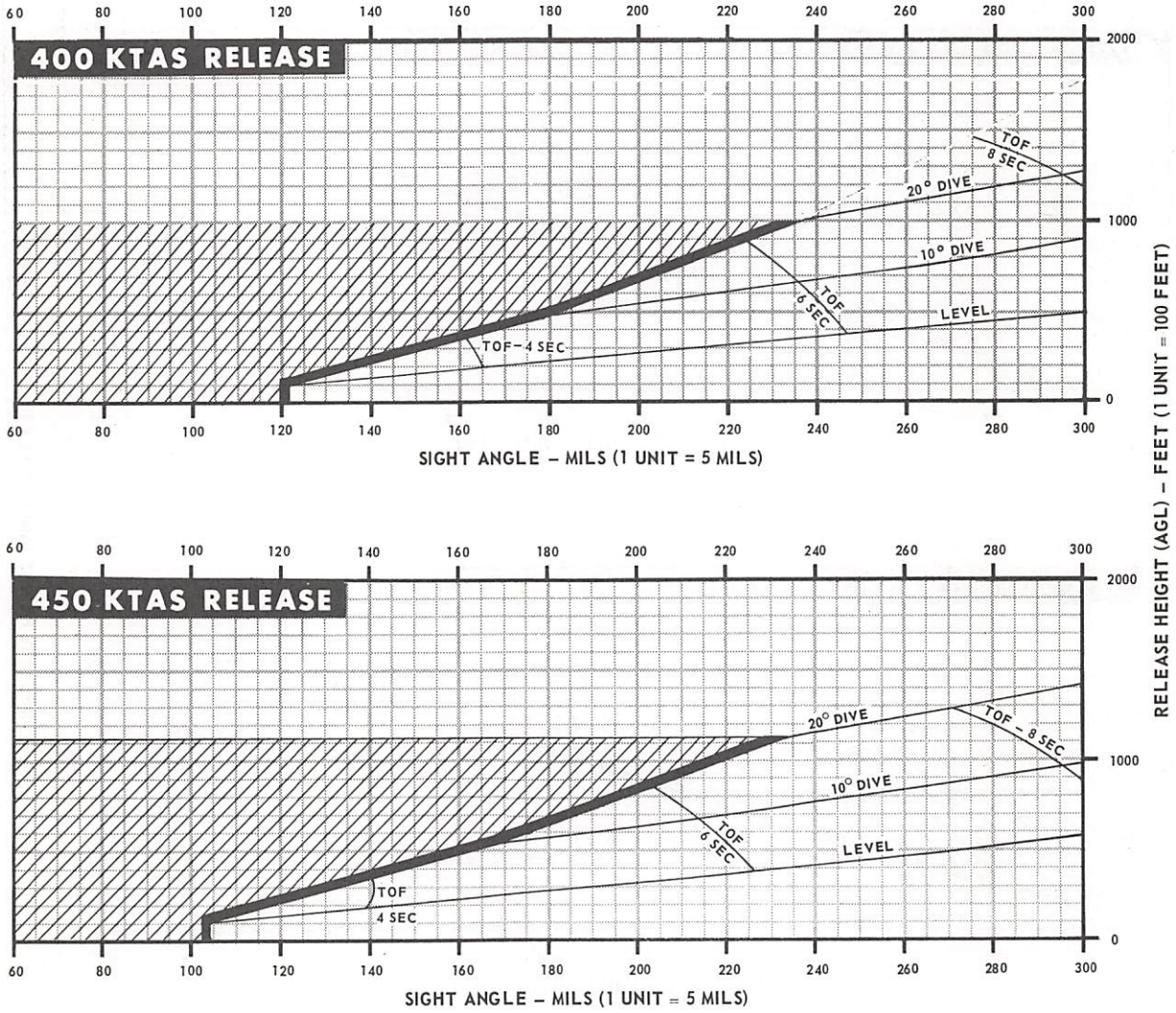
FDB-1T-(178-2)

Figure 2-85 (U) (Sheet 2 of 5)

SIGHT ANGLE
MK 106 MOD 4 PRACTICE BOMB

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

NEW NEW

400 KTAS

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	122	100
10	475	178	200
20	1000	236	300

450 KTAS

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	104	100
10	525	168	200
20	1125	235	300

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 106 MOD 4 PRACTICE: 5 LBS/0.0 FPS

UNCLASSIFIED

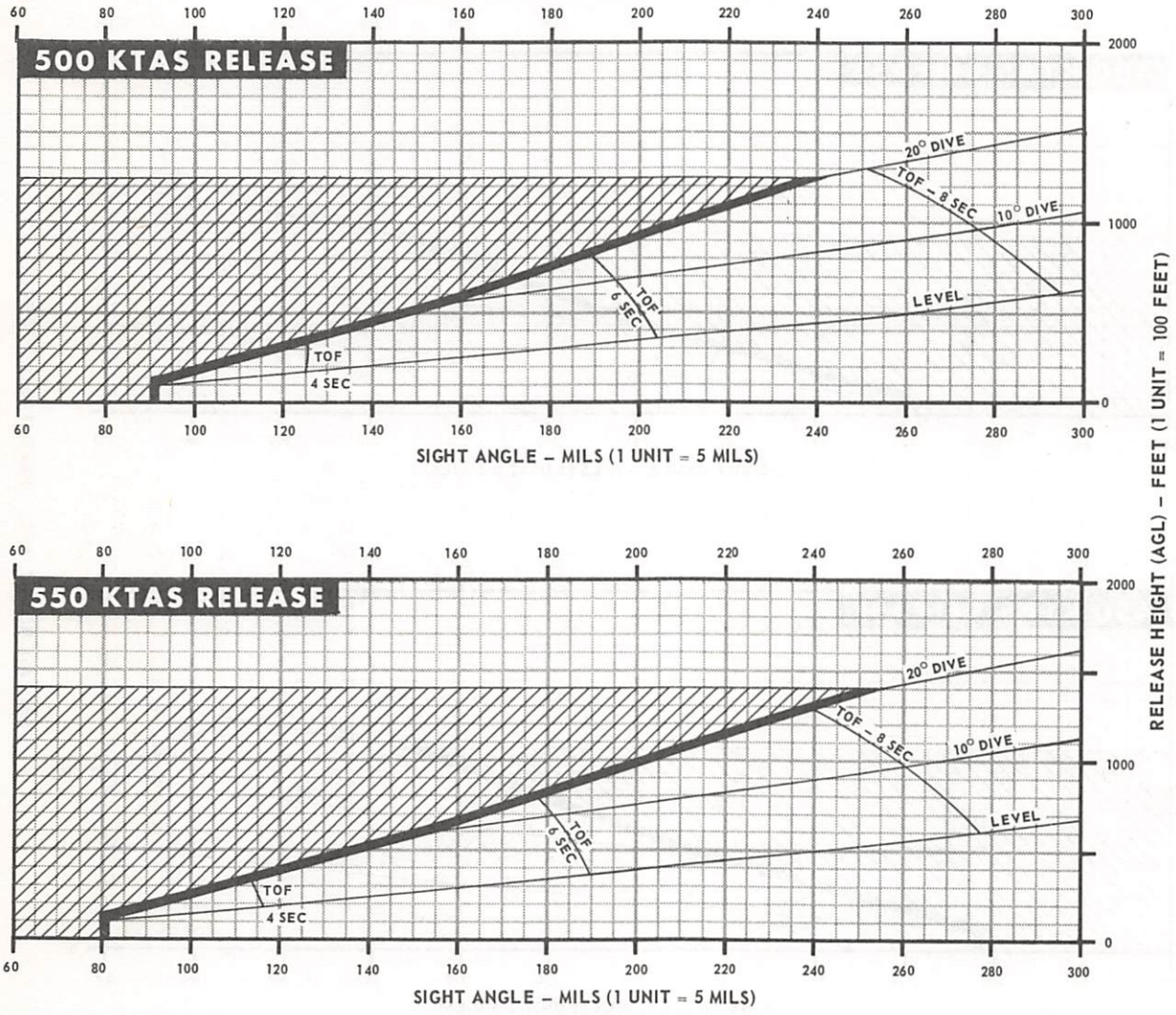
FDB-1T-(178-3)

Figure 2-85 (U) (Sheet 3 of 5)

SIGHT ANGLE
MK 106 MOD 4 PRACTICE BOMB

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

500 KTAS

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	93	100
10	550	158	200
20	1250	241	300

550 KTAS

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOV-ERY ALT (FT)
0	100	82	100
10	600	156	200
20	1400	255	300

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY:

MK 106 MOD 4 PRACTICE: 5 LBS/0.0 FPS

NEW NEW

UNCLASSIFIED

FDB-1T-(178-4)

Figure 2-85 (U) (Sheet 4 of 5)

BOMB SPACING
MK 106 MOD 4 PRACTICE BOMB

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
PMBR EJECTION VELOCITY 0.0 FT/SEC)

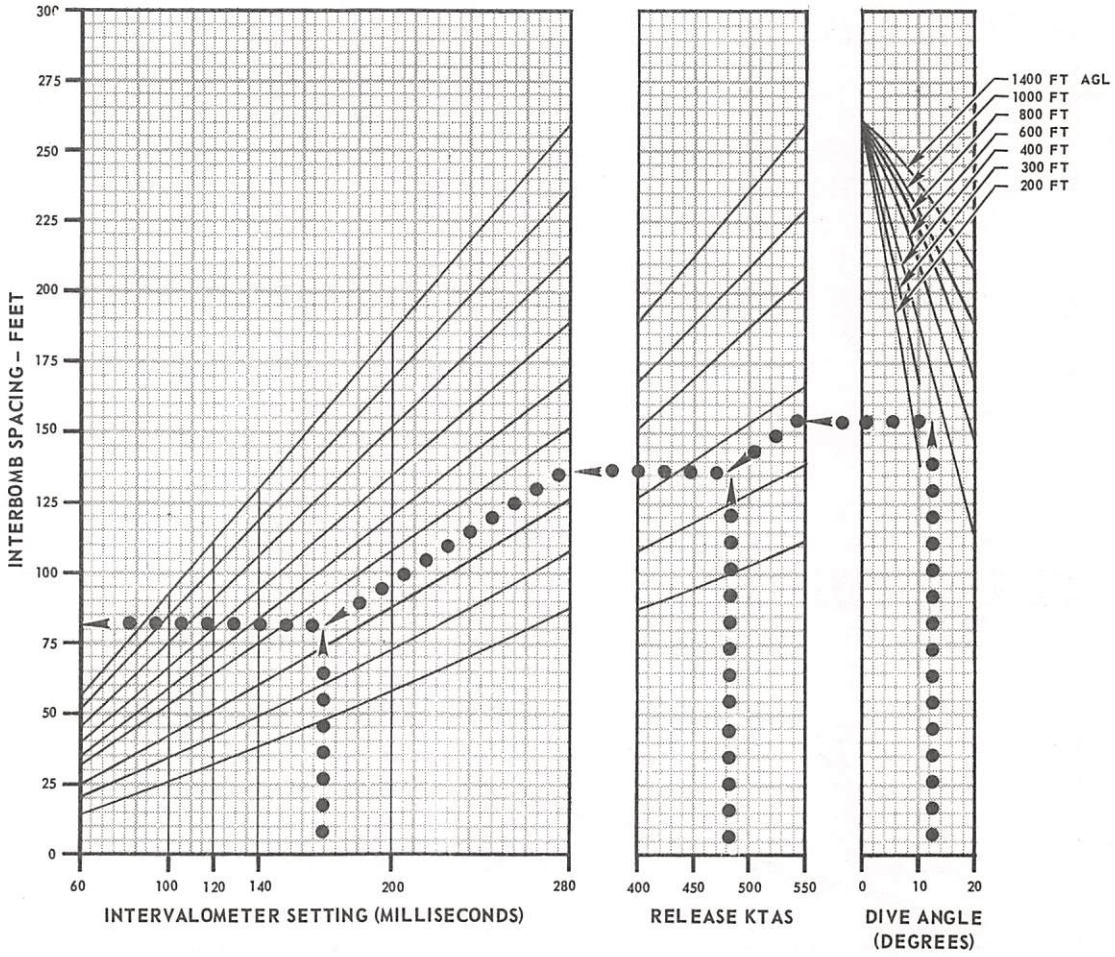
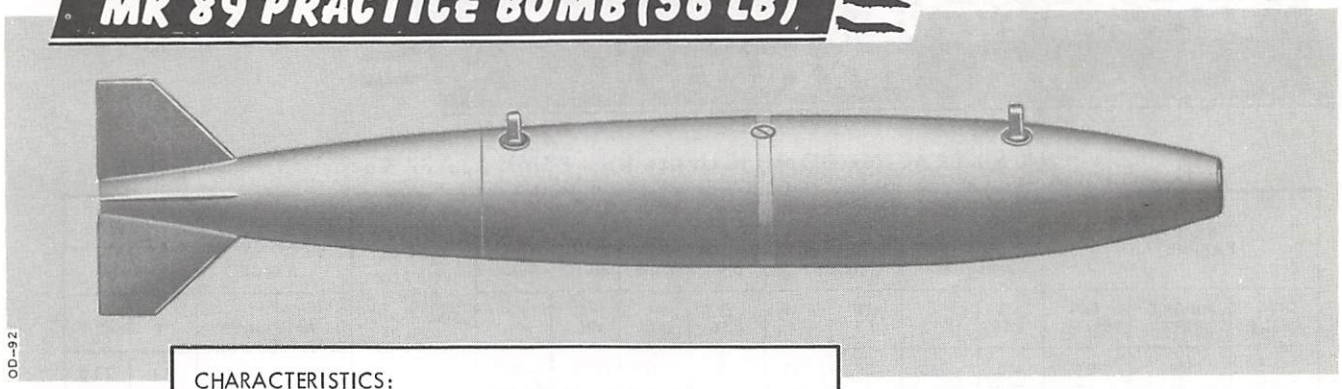


Figure 2-85 (U) (Sheet 5 of 5)

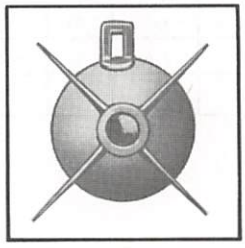
MK 89 PRACTICE BOMB (56 LB)



OD-92

CHARACTERISTICS:	
LENGTH	31.3 INCHES
DIAMETER	4.0 INCHES
WEIGHT	56 POUNDS
SUSPENSION	14 INCHES
FIN SPAN	6.6 INCHES

PAINTING AND MARKING
IDENTIFYING NOMENCLATURE
STENCILED IN WHITE ON BLACK
BOMB BODY.



AFT VIEW

DESCRIPTION

The MK 89 Mod 0 and Mod 1 bomb is a 56-pound practice bomb. It is a low-drag practice bomb similar in shape to the low-drag general purpose bomb. The body is made of cast iron; it is slender, with a long pointed nose. The conical type fin assembly is of welded sheet metal or of cast almag construction. The tail fins are canted 2 degrees to impart spin to the bomb to insure good flight stability.

The MK 4 Mod 3 practice bomb signal is installed in the nose of the bomb. The detonated signal smoke is discharged out the rear of the tail fin.

The MK 89 bomb is designed for impact firing, with MK 4 Mod 0 used to detonate the signal. A cotter pin retains the firing pin and signal.

The single suspension lug is installed in the center hole only when loaded on the A/A 37B-3 Practice Multiple Bomb Rack.

REFERENCES

1. Bomb Assembly . . . . . NAVAIR 11-5A-17
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations. . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-16.1

UNCLASSIFIED

FDB-1T-(179-1)

Figure 2-86 (U) (Sheet 1 of 7)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

MK 89-PRACTICE BOMB (Release from PBMR A/A37 Racks)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	1500	450	153	-153	-250	240	286	-380	34.3	-36.0	7.3	165	4.7	166	22.8
20°	2000	450	37	- 38	- 50	40	37	- 44	10.0	-10.2	4.5	98	9.7	98	21.8
30°	3000	450	31	- 32	- 30	20	27	- 31	8.5	- 8.6	5.1	109	12.7	109	21.4
45°	4000	450	20	- 21	- 10	10	18	- 19	6.8	- 6.8	5.2	109	16.0	108	20.8
60°	6000	500	14	- 15	- 10	10	18	- 19	7.5	- 7.5	6.7	125	16.6	124	18.5

UNCLASSIFIED

FDB-1T-(179-2)

Figure 2-86 (U) (Sheet 2 of 7)

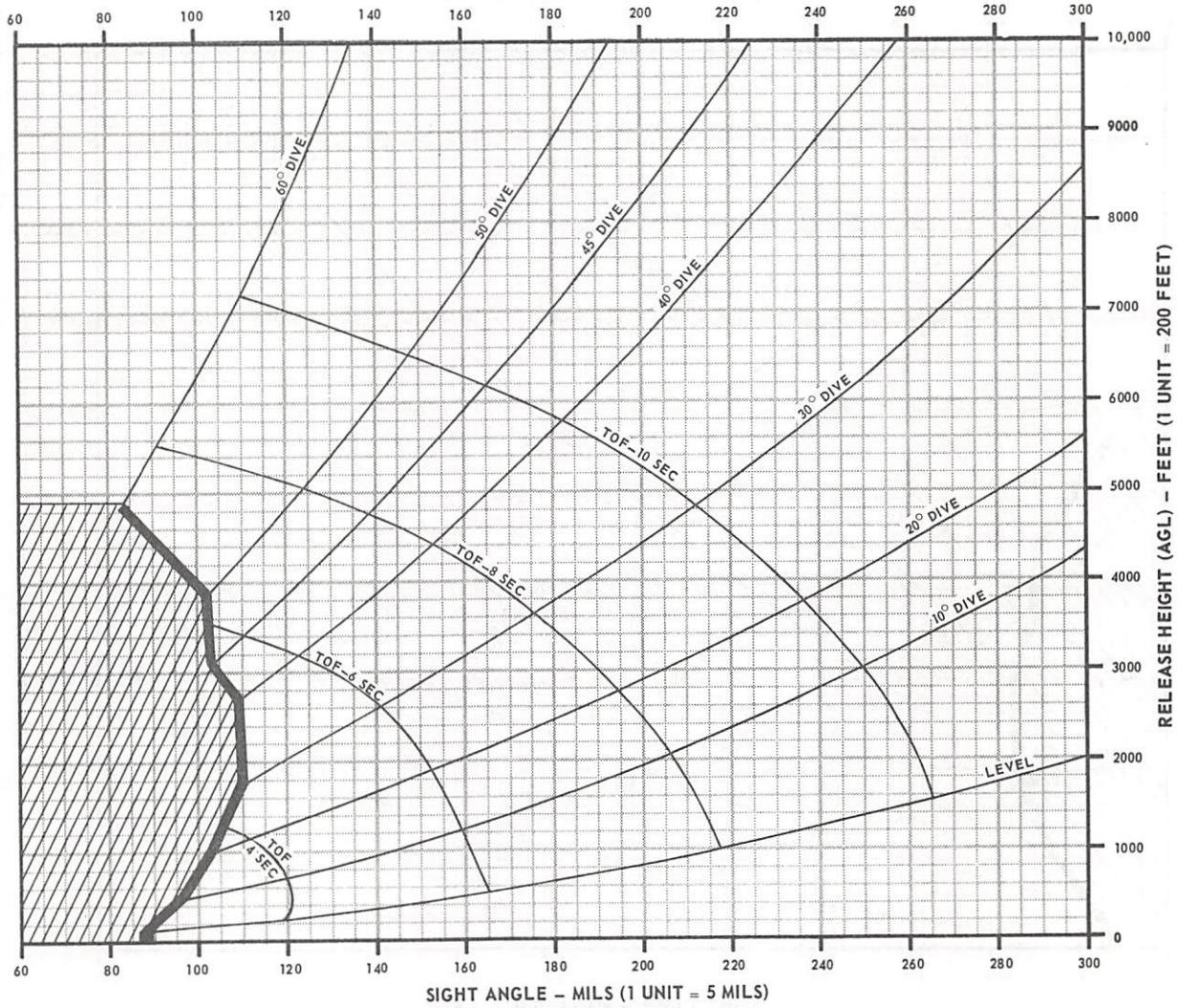
SIGHT ANGLE

MK 89 PRACTICE BOMB

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	89	100
10	475	97	200
20	1000	104	300
30	1775	111	500
40	2725	110	700
45	3150	104	700
50	3925	103	1000
60	4950	83	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: MK 89 PRACTICE: 56 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(179-3)

Figure 2-86 (U) (Sheet 3 of 7)

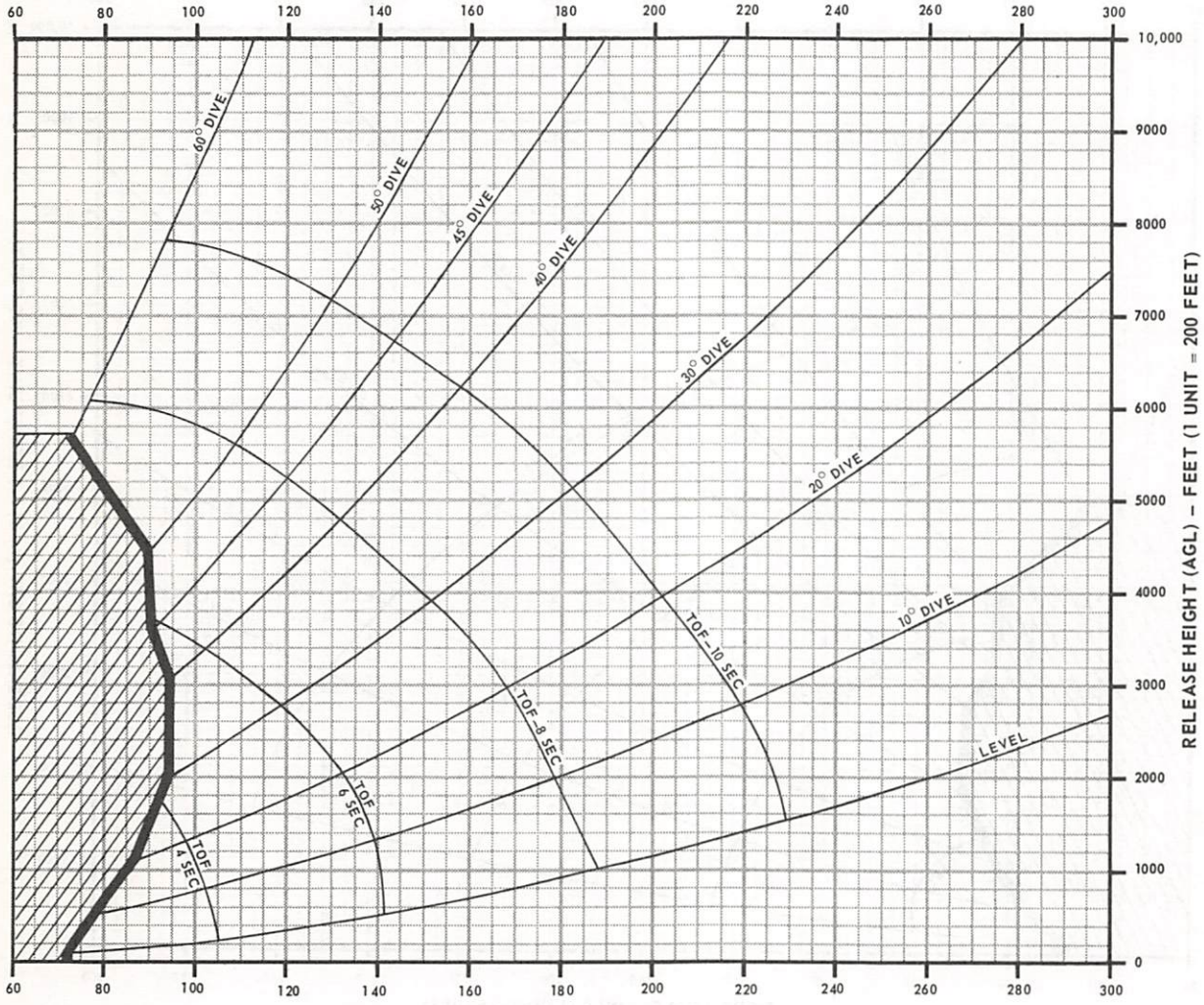
SIGHT ANGLE

MK 89 PRACTICE BOMB

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	73	100
10	525	79	200
20	1125	87	300
30	2025	95	500
40	3125	95	700
45	3650	91	700
50	4525	90	1000
60	5750	73	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: MK 89 PRACTICE: 56 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(179-4)

Figure 2-86 (U) (Sheet 4 of 7)

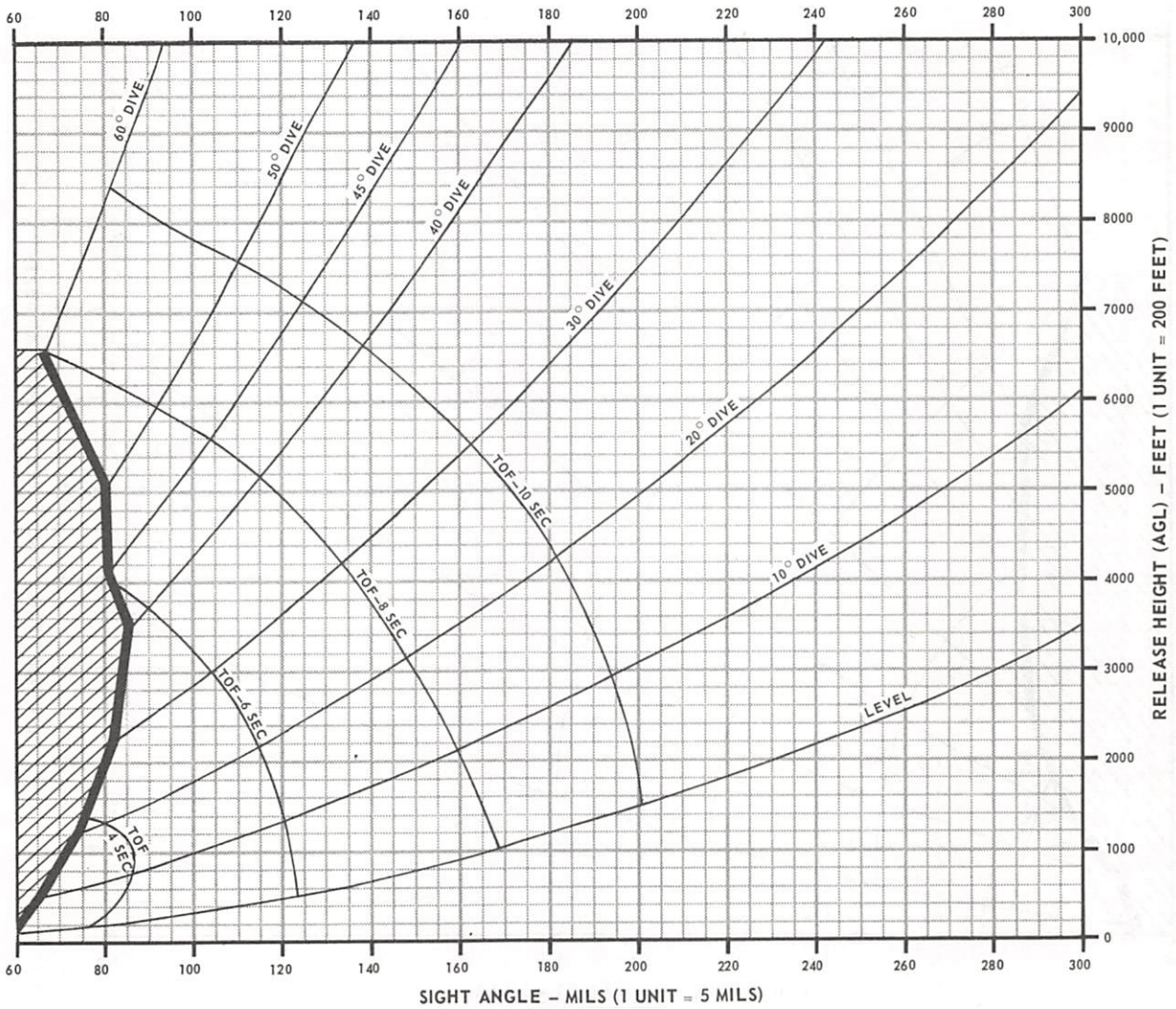
SIGHT ANGLE

MK 89 PRACTICE BOMB

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	60	100
10	550	66	200
20	1250	75	300
30	2300	83	500
40	3550	86	700
45	4175	82	700
50	5125	81	1000
60	6600	67	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: MK 89 PRACTICE: 56 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(179-5)

Figure 2-86 (U) (Sheet 5 of 7)

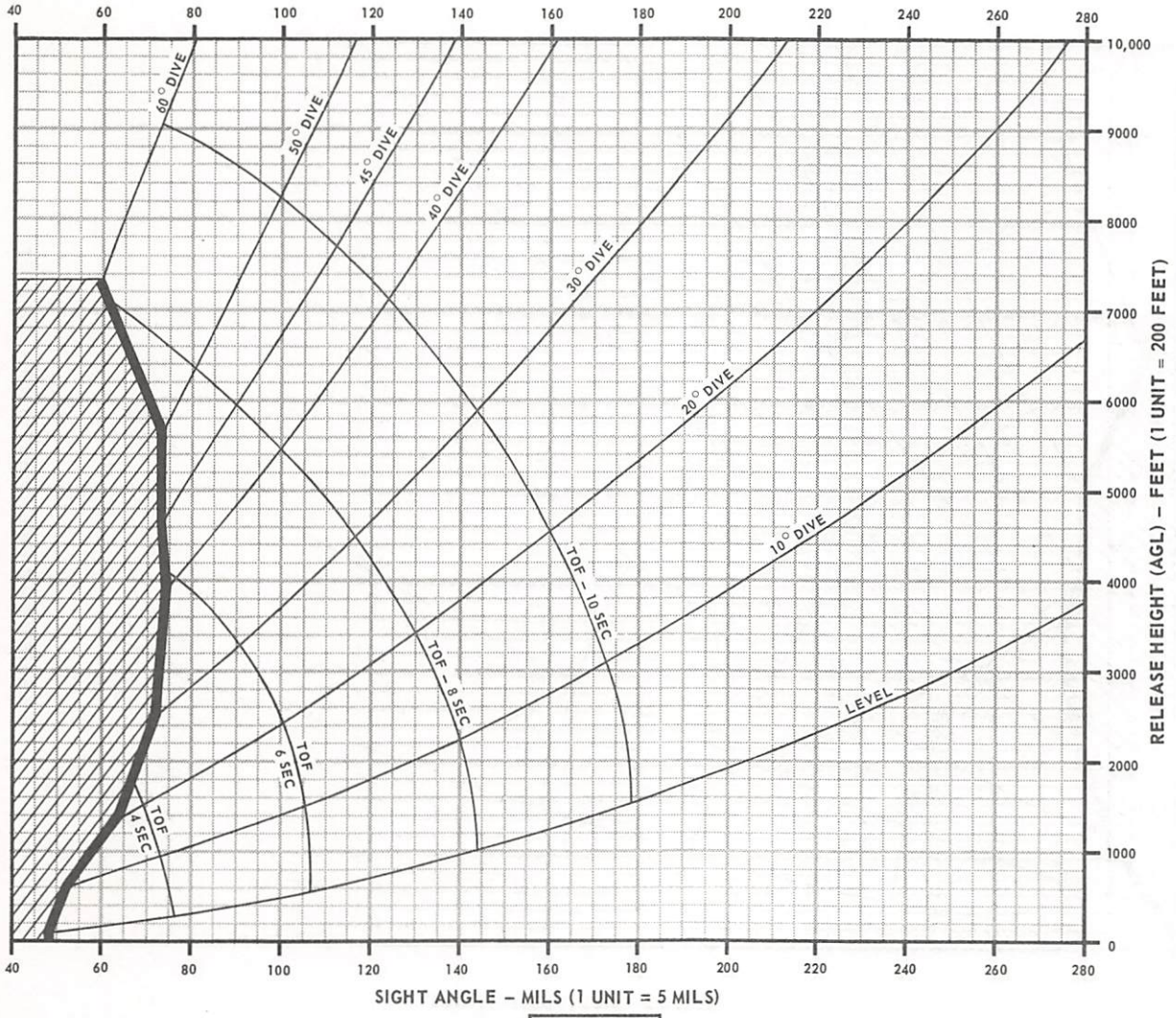
SIGHT ANGLE

MK 89 PRACTICE BOMB

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

TERRAIN AVOIDANCE			
DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	100	49	100
10	600	53	200
20	1400	65	300
30	2550	73	500
40	3975	75	700
45	4675	74	700
50	5725	74	1000
60	7350	60	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: MK 89 PRACTICE: 56 LBS/0.0 FPS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(179-6)

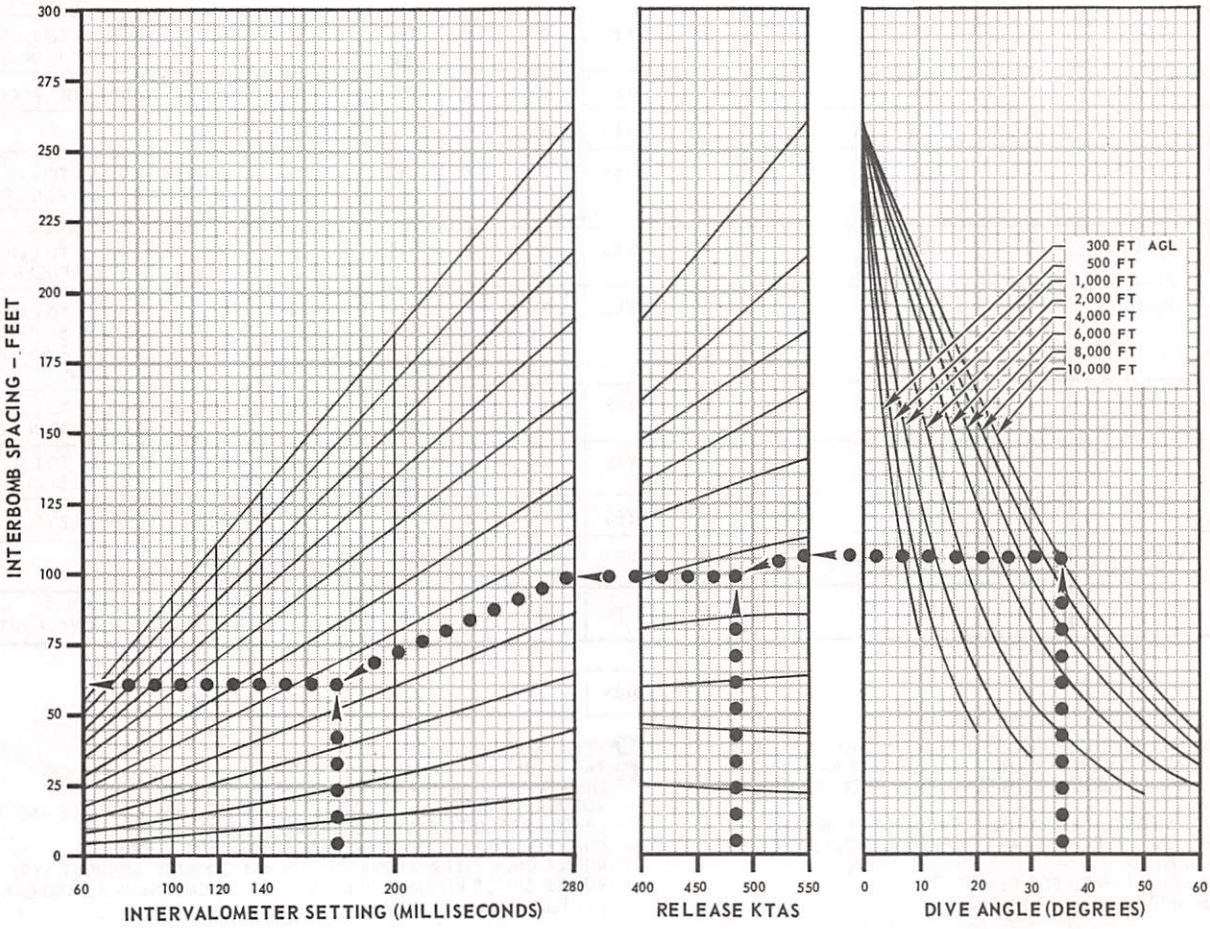
Figure 2-86 (U) (Sheet 6 of 7)

BOMB SPACING
MK89 PRACTICE BOMB

Note

USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
PMBR EJECTION VELOCITY 0.0 FT/SEC)



UNCLASSIFIED

FDB-1T-(179-7)

Figure 2-86 (U) (Sheet 7 of 7)

ROCKET LAUNCHER COMPARISONS

ROCKET SIZE (IN.)	LAUNCHER DESIGNATION	NUMBER ROUNDS	USED AS SHIPPING CONTAINER [2]	LAUNCHER TUBES		HERO SAFE	INTER-VALOMETER		LOADED WEIGHT (LB) [3]	LENGTH (IN.) [4]	SAFE ARM DEVICE	REMARKS
				PAPER (ONE TIME USE)	METAL (RE-USABLE)		RIPPLE	S				
2.75	LAU-32A/A	7	YES	X		YES	X		174	48	PIN	
2.75	LAU-32B/A [1]	7	YES		X	YES	X	X	175	48	PIN	SIMILAR TO LAU-32A/A BUT IS REUSABLE
2.75	LAU-56A	7	YES	X		YES	X	X	188	48	PIN	SIMILAR TO LAU-32A/A BUT HAS RIPPLE/SINGLE CAPABILITY
2.75	LAU-68A	7	YES		X	YES	X	X	200 [5]	58	PIN	SIMILAR TO LAU-32B/A EXCEPT 10 IN. LONGER
2.75	LAU-70A	7	YES		X	YES	X	X	200	58	PIN	UNDER DEVELOPMENT
2.75	LAU-3A/A	19	YES	X		YES	X		431	48	PIN	
2.75	LAU-50A	19	NO	X		YES	X	X	415	48	SHORTING BUTTON	SIMILAR TO LAU-3A/A BUT HAS RIPPLE/SINGLE CAPABILITY
2.75	LAU-51A	19	NO		X	YES	X	X	415	48	PIN	SIMILAR TO LAU-50A BUT IS REUSABLE
2.75	LAU-60A	19	YES	X		YES	X		434	48	PIN	SIMILAR TO LAU-3A/A EXCEPT SHIPPING PAN ALLOWS 2 IN. CLEARANCE. [6]
2.75	LAU-61A	19	YES		X	YES	X	X	502 [5]	58	PIN	SIMILAR TO LAU-51A EXCEPT 10 IN. LONGER
2.75	LAU-69A	19	YES	X		YES	X	X	483 [5]	58	PIN	SIMILAR TO LAU-3A/A EXCEPT 10 IN. LONGER
2.75	LAU-71A	19	YES		X	YES	X	X	525	58	PIN	UNDER DEVELOPMENT
5.00	LAU-10A/A	4	YES		X	YES	X	X	533	95.5	PIN	
5.00	LAU-33A/A	2	NO		X	YES	X	X	286	99.2	PIN	USES AIM-9 LAUNCH CIRCUIT

Notes

1. LAUNCHER IS PURCHASED BY BOTH USAF AND USN. USAF PURCHASES HAVE NO HERO FIX AND ARE MADE SAFE BY A SHORTING CLIP. USN HAS HERO FIX WITH PULL PIN SAFETY. EXAMPLE: LAU-32B/A
2. LAUNCHERS PURCHASED BY USN SERVE AS SHIPPING CONTAINERS. USAF PURCHASES ARE SHIPPED WITHOUT ROCKETS TO DESTINATION.
3. WITH FAIRING READIED FOR FLIGHT.
4. WITHOUT SHIPPING PAN OR FAIRINGS.
5. WEIGHTS APPROXIMATE.
6. TWO INCHES ADDITIONAL SPACE WAS PROVIDED TO ALLOW ROCKETS TO BE SHIPPED IN LAUNCHER WITH M423 FUZE INSTALLED.
7. NOT ALL LAUNCHERS LISTED ARE AUTHORIZED FOR CARRIAGE AND RELEASE. REFER TO EXTERNAL STORES LIMITATIONS.
8. NINETEEN ROUND LAUNCHERS FIRE 9 PAIRS AND 1 SINGLE.
9. RIPPLE ONLY INTERVALOMETER IS PLASTIC, SHUNT, BURNOUT TYPE.
10. RIPPLE/SINGLE INTERVALOMETER IS ELECTROMECHANICAL AND CAN BE SET FOR RIPPLE OR SINGLE.

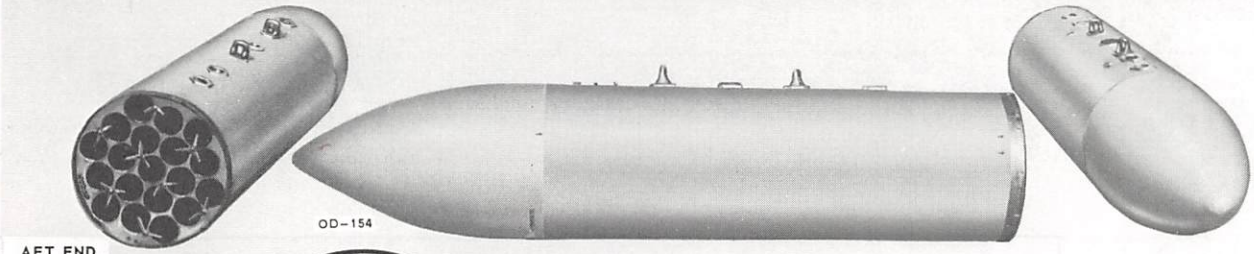
UNCLASSIFIED

FDB-1T-(180)

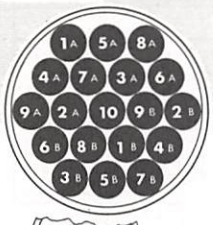
Figure 2-87 (U)

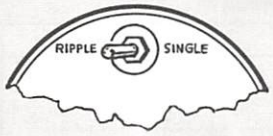
AERO 7D LAU-3A/A, -60/A, -61/A, -69/A, ROCKET LAUNCHERS

19-2.75 INCH FFAR

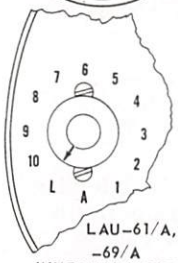


AFT END





LAU-61/A AND LAU-69/A MODE SELECTOR SWITCH ON AFT BULKHEAD



LAU-61/A, -69/A INTERVALOMETER

	AERO 7D	LAU-60/A
LENGTH	7 FEET, 10.5 INCHES	7 FEET, 2.5 INCHES
DIAMETER	15.75 INCHES	15.50 INCHES
WEIGHT*		
FIRING RATE	10 MSEC	10 MSEC

	LAU-69/A	LAU-3A/A	LAU-61/A
LENGTH	6 FEET, 11 INCHES	7 FEET, 10.5 INCHES	6 FEET, 11 INCHES
DIAMETER	15.75 INCHES	15.75 INCHES	15.75 INCHES
WEIGHT*			
FIRING RATE	17-23 MSEC	10 MSEC	17-23 MSEC

* FOR THE WEIGHT OF THE VARIOUS ROCKET LAUNCHER/WARHEAD/FUZE CONFIGURATIONS, REFER TO DRAG INDEX AND WEIGHT, APPENDIX A.

DESCRIPTION

The Aero 7D, LAU-69/A, LAU-3A/A or LAU-60/A is a disposable rocket launching unit containing nineteen 2.75 inch folding fin aircraft rockets. The LAU-61/A is a reusable rocket launcher. The package is made up of one center section and two frangible fairings, one attached to each end of the launching unit. These frangible fairings are shattered when the rockets are fired. Rocket firing is accomplished by an intervalometer mounted inside the package. Each intervalometer pulse fires two rockets. The package center section contains electrical receptacles for connection of airplane wiring and suspension lugs.

The launcher package is fired by depressing the bomb button located on the pilot's control stick. The package will fire in pairs as long as the switch is closed or until the package is empty. The term "ballistic dispersion" describes those impact errors, not controllable by the pilot, that result from random variations in rocket launching and flight. Such variations may stem, for example, from rocket-to-rocket differences in burning rate, from differences in fin opening delay and alignment, or from the effects of air turbulence near the launcher. It has been determined that clusters of FFAR rockets spread during flight with an average ballistic dispersion of about 12 mils in both the range and deflection. The 2.75 inch FFAR delivery data can be used for all launchers.

REFERENCES

1. 2.75-inch FFAR . . . . . OP 1793
2. Rocket Assemblies . . . . . OP 1415
3. Rocket Launcher, Aero 7D . . . . . NAVAIR 11-5-597
4. USN Ordnance Safety Precautions . . . . . OP 3347
5. Aircraft Rockets . . . . . NAVAIR 11-85-5
6. External Store Limitations . . . . . Appendix A
7. Fuzing and Fuze Limitations . . . . . Section II Part 1
8. Loading Procedures, Arming Wire Configuration, and Suspension Equipment . . NAVAIR 01-245FDB-75
9. Current AAB's.
10. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-12.1

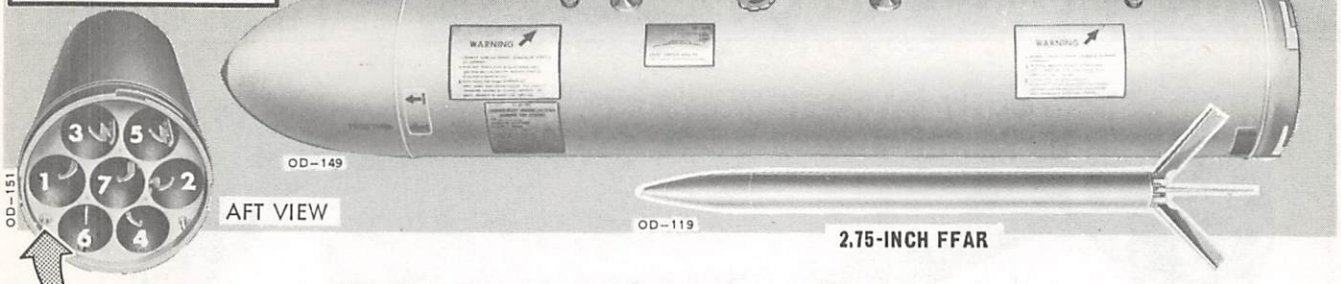
UNCLASSIFIED

FDB-1T-(181-1)

Figure 2-88 (U) (Sheet 1 of 9)

LAU-32A/A, -32B/A, -56/A, -68/A ROCKET LAUNCHERS

7 FFAR 2.75-INCH



MODE SELECTOR SWITCH ON AFT BULKHEAD (LAU-32B/A, LAU-56/A AND LAU-68/A)

PHYSICAL CHARACTERISTICS				
	LAU-32A/A	LAU-32B/A	LAU-56/A	LAU-68/A
WEIGHT*				
LENGTH	67 INCHES	67 INCHES	62 INCHES	71 INCHES
DIAMETER	10 INCHES	10 INCHES	10 INCHES	10 INCHES
CAPACITY	7-2.75 IN. FFAR	7-2.75 IN. FFAR	7-2.75 IN. FFAR	7-2.75 IN. FFAR
EXPENDABLE	YES	NO	NO	NO
RADHAZ SAFE	YES	YES	YES	YES
SINGLE FIRE	NO	YES	YES	YES
FIRING RATE	10 MS INT	17.23 MS INT	17.23 MS INT	17.23 MS INT

* FOR THE WEIGHT OF THE VARIOUS ROCKET LAUNCHER/WARHEAD/FUZE CONFIGURATIONS, REFER TO DRAG INDEX AND WEIGHT, APPENDIX A.

Note

1. THE LAU-32A/A ROCKET LAUNCHER INCORPORATES A CLOSED AFT FAIRING.
2. THE LAU-68/A ROCKET LAUNCHER CAN ALSO USE THE MK 51 ROCKET HEAD.

DESCRIPTION

The LAU-32A/A or Aero 6A-2, or LAU-68/A rocket launcher carries and launches seven 2.75-inch folding fin aircraft rockets (FFAR). The flight configuration consists of the loaded center-section assembly with streamlined fairings installed and locked onto the ends. When the launcher is fired, the front fairing is shattered by rocket impact, and the tip of rear fairing is shattered by rocket blast. The frangible fairings are made of an impregnated molded fibre, designed with a waffle type structure which is shattered readily by the impact of the rocket. The aft fairing is molded in two sections, such that the rocket blast shatters the center portion while the base section remains to act as a funnel to direct debris away from the aircraft. When attached, the fairing is flush with the outside surface to provide an aerodynamically smooth joint.

The launcher center section is constructed of seven paper tubes clustered and bonded together to form an integral part of the structure and wrapped with a thin aluminum outer skin. Detent devices within the tubes restrain the rockets against normal flight loads and provide electrical contact to ignite the rockets. Contact fingers on the aft bulkhead provide a ground to complete the circuit through the rockets. Two receptacles on top of the center section provide the connection to the aircraft rocket-firing circuitry. These receptacles are wired in parallel; therefore, only one of them is connected to the aircraft. A shorting button is inserted into the other as a ground safety device which is removed prior to flight. Electrical power for the rocket ignition system is supplied to the launcher by the 28-volt d-c armament circuit of the aircraft. The burnout, wire type intervalometer, located within the LAU-32A/A launcher, converts the aircraft firing voltage into a ripple fire pulse with a 10-millisecond delay interval. The rockets will ripple fire until the launcher is empty or the bomb button (pickle button) is released. The launcher should completely fire-out in approximately 0.2 second. The LAU-32A/A intervalometer is the same, and interchangeable with the LAU-3/A launcher. The 2.75" Delivery Data is applicable to all launcher Mode. The LAU-68/A is re-usable and has a re-usable intervalometer.

REFERENCES

1. 2.75 - inch FFAR . . . . . OP 1793
2. Rocket Assemblies . . . . . OP 1415
3. USN Ordinance Safety Precautions . . . . . OP 3347
4. Aircraft Rockets . . . . . NAVAIR 11-85-5
5. External Store Limitations . . . . . Appendix A
6. Fuzing and Fuze Limitations . . . . . Section II Part 1
7. Loading Procedures, Arming Wire Configuration, and Suspension Equipment . . NAVAIR 01-245FDB-75
8. Current AAB's
9. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-12.1

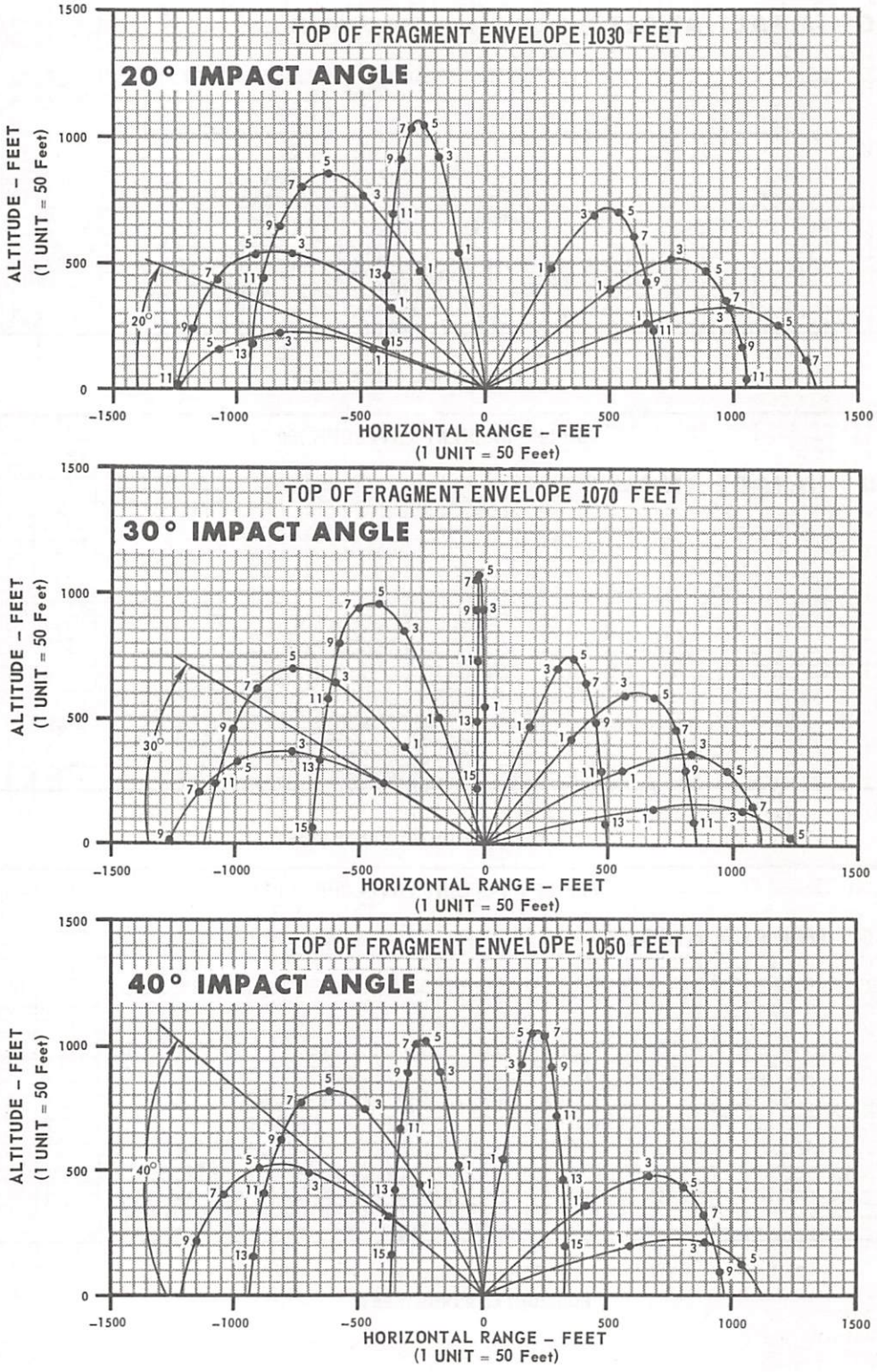
UNCLASSIFIED

FDB-1T-(181-2)

Figure 2-88 (U) (Sheet 2 of 9)

MAXIMUM FRAGMENT ENVELOPE
2.75-INCH FFAR WITH MK I MOD I WARHEAD

NOTE
FRAGMENT TIME IN SECONDS IS GIVEN ADJACENT TO EACH POINT



FDB-1T-(181-4)

UNCLASSIFIED

Figure 2-88 (U) (Sheet 3 of 9)

MAXIMUM FRAGMENT ENVELOPE
2.75 - INCH FFAR WITH M151 WARHEAD

NOTE
FRAGMENT TIME IN SECONDS IS GIVEN ADJACENT TO EACH DATA POINT

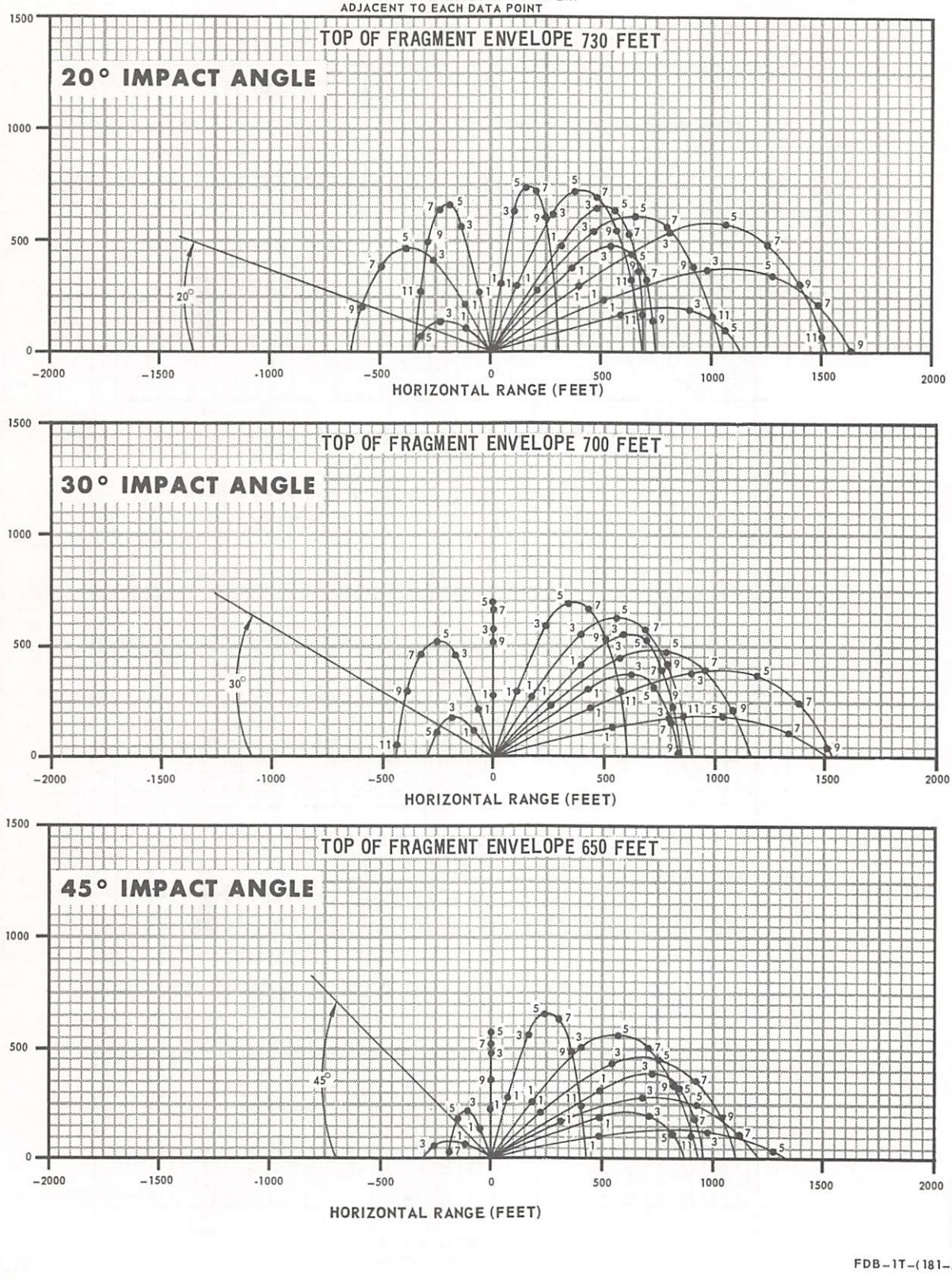


Figure 2-88 (U) (Sheet 4 of 9)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

2.75-INCH FFAR ROCKET (MK 1 AND 5 WARHEAD)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KNOTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT Slant Range 1000 Ft	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL		FT	MILS	FT	MILS
10°	2000	450	20.2	–20.5	–71	63	92	–150	44.0	–46.1	9.5	77	1.7	78	8.2
20°	2000	450	5.2	– 5.3	–10	9	10	– 12	14.8	–15.2	5.5	43	2.9	43	7.8
	3000	450	8.8	– 9.0	–16	15	22	– 29	21.5	–22.1	8.1	63	2.9	63	7.8
30°	3000	450	3.6	– 3.7	– 5	4	6	– 7	11.0	–11.2	5.8	44	4.0	45	7.8
	5000	500	6.7	– 6.9	– 9	8	17	– 20	17.9	–18.2	9.5	74	4.1	73	7.7
45°	4000	450	2.0	– 2.0	– 2	2	4	– 4	7.7	– 7.7	5.5	43	5.6	42	7.7
	6000	500	3.2	– 3.2	– 3	3	7	– 8	11.4	–11.5	8.3	62	5.4	62	7.5
60°	7000	500	1.7	– 1.8	– 1	1	5	– 5	9.1	– 9.2	8.0	59	6.5	59	7.4

2.75-INCH ROCKET (M151 WARHEAD)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, – SHORT)									RELATIVE WIND – 10 KNOTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT Slant Range 1000 Ft	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	–10 KTS	+100 FT	–100 FT	+1 DEG	–1 DEG	+1 MIL	–1 MIL		FT	MILS	FT	MILS
10°	1000	450	10.1	–10.3	–42	35	28	– 45	24.0	–25.2	5.0	44	1.8	45	8.9
	2000	450	22.8	–23.2	–88	79	111	–175	41.0	–42.9	9.2	88	2.1	88	9.6
20°	2000	450	6.1	– 6.3	–13	12	12	– 16	14.5	–14.9	5.4	49	3.3	47	8.8
	3000	450	10.7	–10.9	–22	21	29	– 38	20.9	–21.4	8.0	72	3.4	73	9.1
30°	3000	450	4.3	– 4.4	– 6	6	8	– 9	10.9	–11.0	5.7	50	4.6	50	8.8
	5000	500	8.3	– 8.5	–13	12	22	– 27	17.5	–17.8	9.4	85	4.8	85	9.1
45°	4000	450	2.4	– 2.5	– 3	2	4	– 5	7.6	– 7.7	5.5	48	6.3	48	8.7
	6000	500	4.0	– 4.1	– 4	4	9	– 10	11.3	–11.4	8.3	71	6.3	72	8.7
60°	7000	500	2.2	– 2.2	– 2	2	6	– 6	9.1	– 9.1	8.0	68	7.5	69	8.6

UNCLASSIFIED

FDB-1T-(181-6)

Figure 2-88 (U) (Sheet 5 of 9)

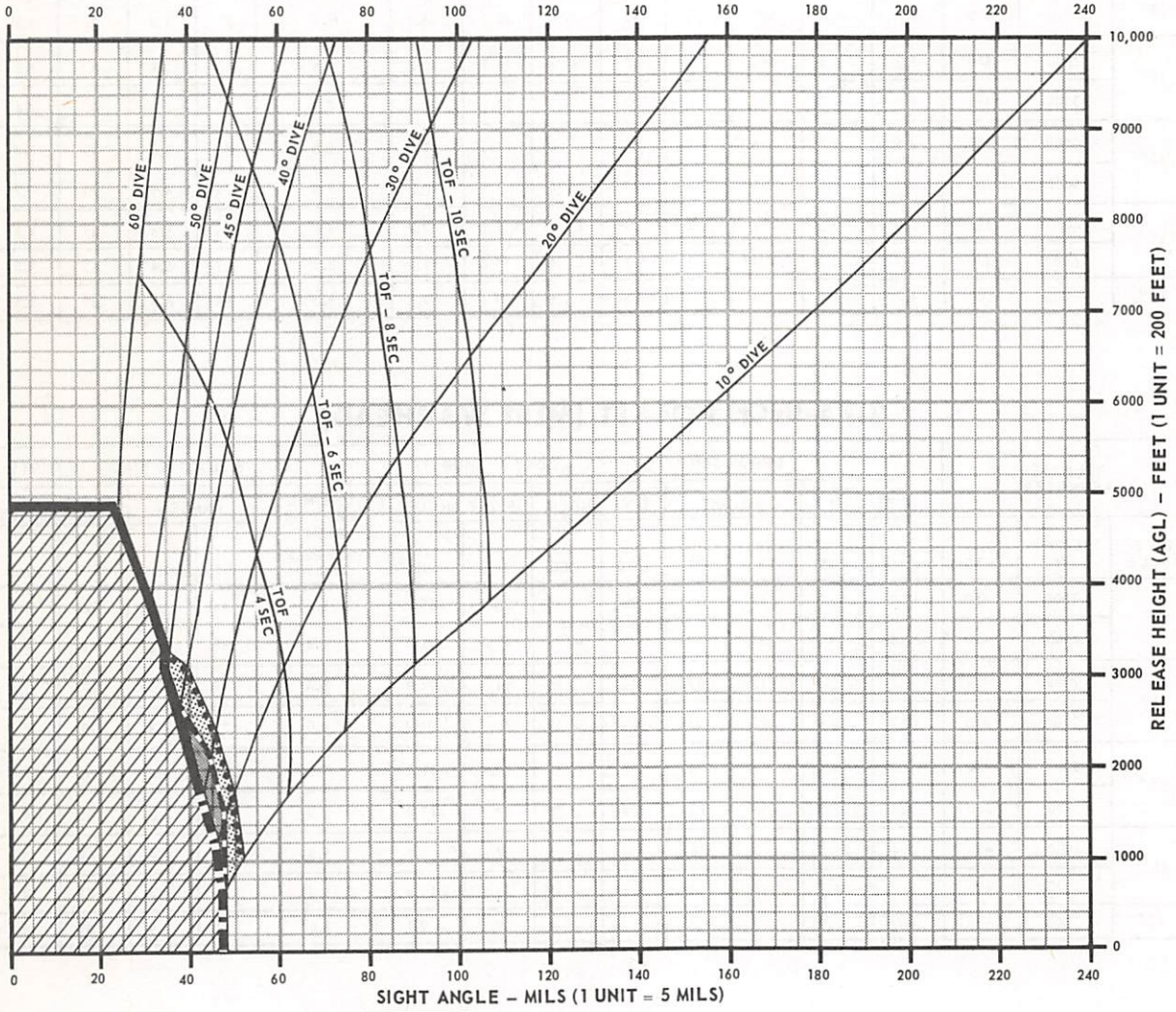
SIGHT ANGLE

2.75-INCH FFAR WITH MK 1 AND MK 5 WARHEADS

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	1000	52	725	700	49	425	675	49	400
20	1700	50	1000	1550	49	850	1225	47	525
30	2400	46	1125	2150	45	875	1775	43	500
40	3100	40	1075	2725	38	700	2725	38	700
45	3300	36	850	3150	36	700	3150	36	700
50	3925	32	1000	3925	32	1000	3925	32	1000
60	4950	24	1000	4950	24	1000	4950	24	1000

FRAG
TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT:
2.75 INCH FFAR: 17.63 LBS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(181-7)

Figure 2-88 (U) (Sheet 6 of 9)

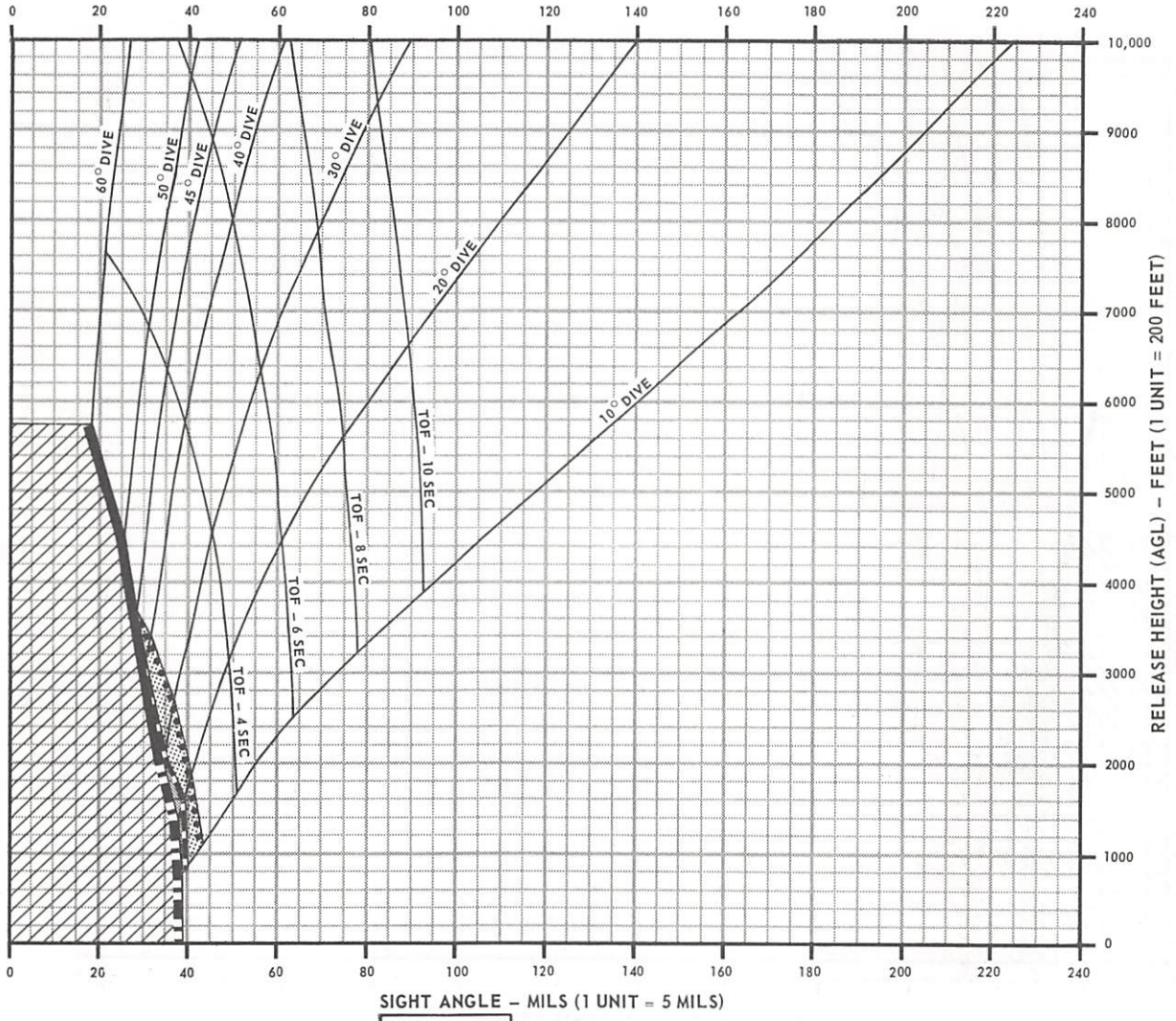
SIGHT ANGLE

2.75-INCH FFAR WITH MK 1 AND MK 5 WARHEADS

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	1100	44	775	800	40	475	775	39	450
20	1900	41	1075	1625	39	800	1375	38	550
30	2700	37	1175	2125	35	600	2025	35	500
40	3400	32	975	3125	31	700	3125	31	700
45	3700	29	750	3650	29	700	3650	29	700
50	4525	26	1000	4525	26	1000	4525	26	1000
60	5750	19	1000	5750	19	1000	5750	19	1000

FRAG
TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT:
2.75 INCH FFAR: 17.63 LBS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(181-8)

Figure 2-88 (U) (Sheet 7 of 9)

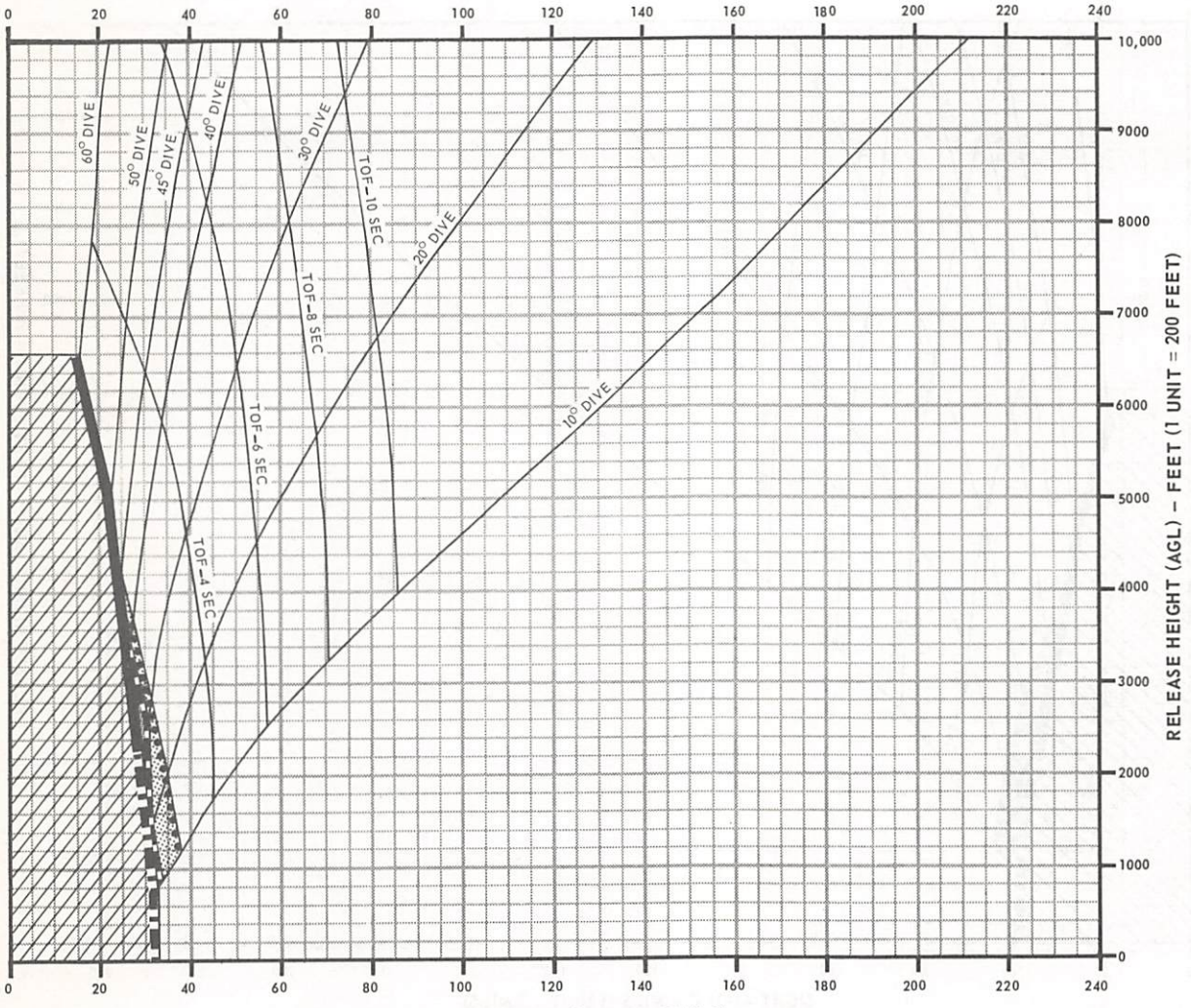
SIGHT ANGLE

2.75-INCH FFAR WITH MK 1 AND MK 5 WARHEADS

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	1200	38	850	900	34	550	825	33	475
20	2000	35	1050	1525	32	575	1500	32	550
30	2900	32	1100	2575	31	775	2300	29	500
40	3700	28	850	3550	27	700	3550	27	700
45	4175	25	700	4175	25	700	4175	25	700
50	5125	23	1000	5125	23	1000	5125	23	1000
60	6600	16	1000	6600	16	1000	6600	16	1000

FRAG
TERRAIN

WEAPON BALLISTIC REFERENCE WEIGHT:
2.75 INCH FFAR: 17.63 LBS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

NEW NEW NEW

UNCLASSIFIED

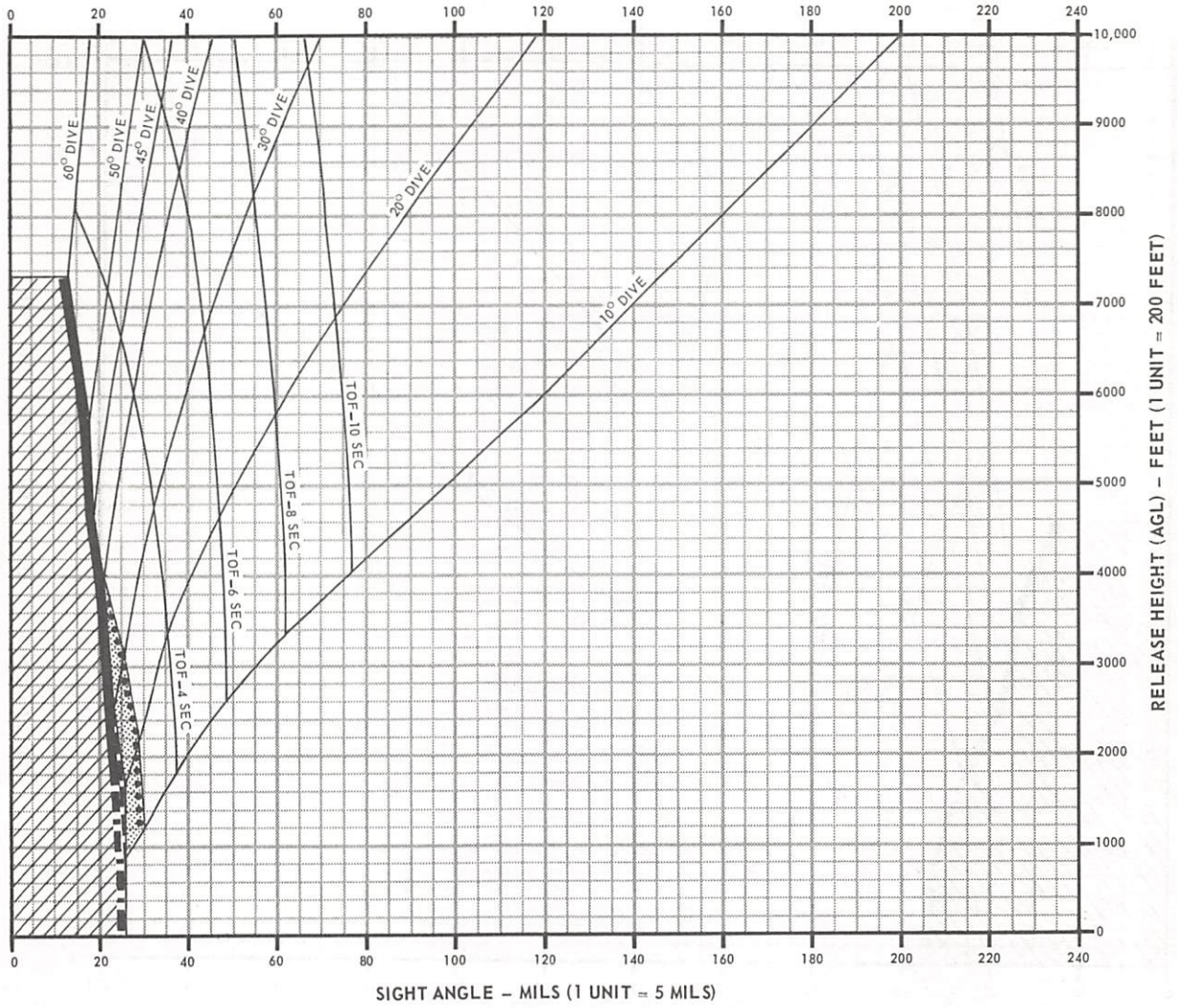
FDB-1T-(181-9)

Figure 2-88 (U) (Sheet 8 of 9)

SIGHT ANGLE
2.75-INCH FFAR WITH MK1 AND MK 5 WARHEADS
550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	1200	30	800	900	26	500	875	26	475
20	2200	29	1100	1700	26	600	1650	26	550
30	3100	26	1050	2550	24	500	2550	24	500
FRAG 40	4000	22	725	3975	22	700	3975	22	700
TERRAIN 45	4675	21	700	4675	21	700	4675	21	700
50	5725	20	1000	5725	20	1000	5725	20	1000
60	7350	14	1000	7350	14	1000	7350	14	1000

WEAPON BALLISTIC REFERENCE WEIGHT:
2.75 INCH FFAR: 17.63 LBS

0.000 HIT PROBABILITY
0.001 HIT PROBABILITY
0.010 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(181-10)

Figure 2-88 (U) (Sheet 9 of 9)

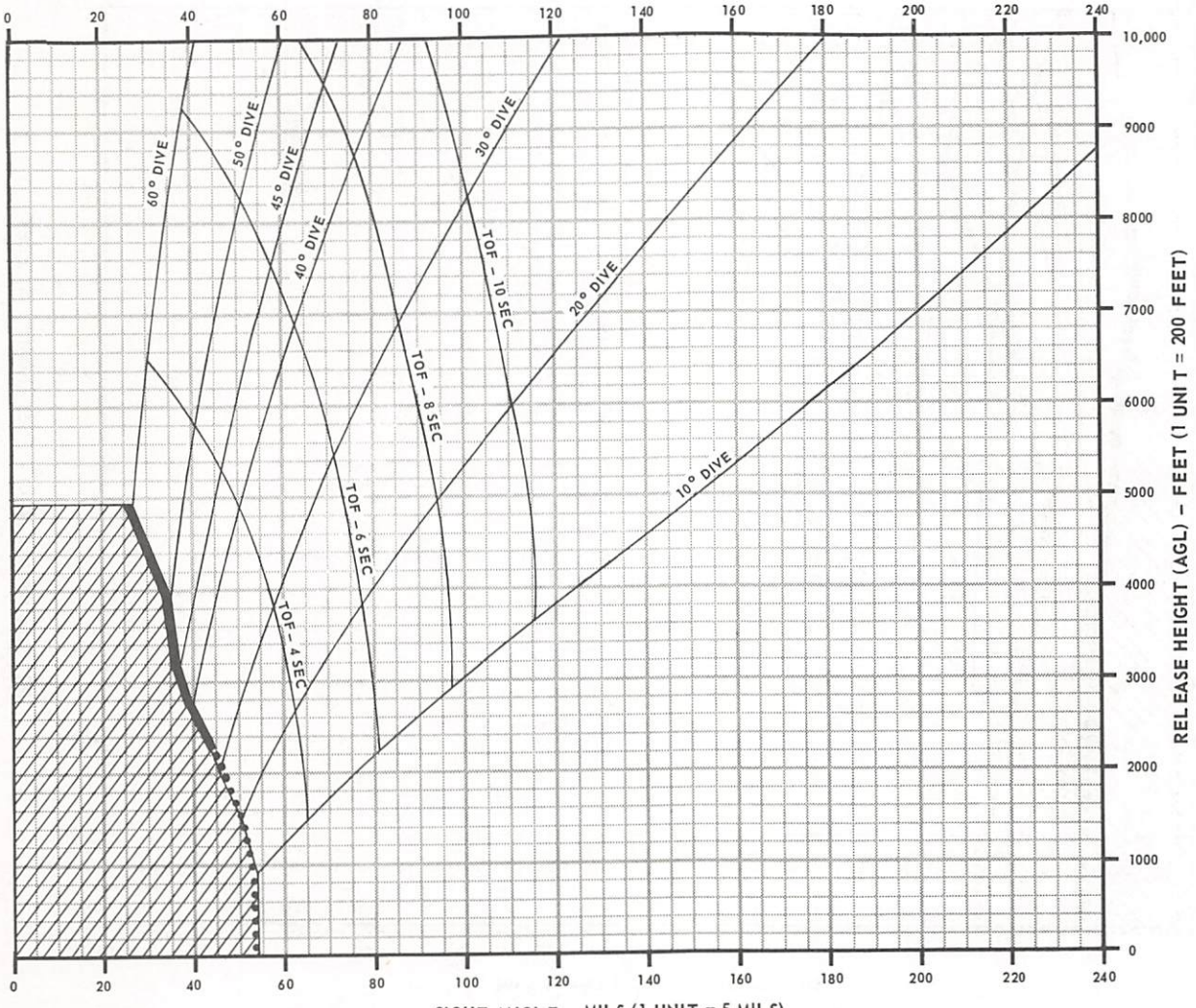
SIGHT ANGLE

2.75 INCH FFAR WITH M151 WARHEAD

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	900	54	625						
20	1500	51	800						
FRAG 30	2100	46	825						
TERRAIN 40	2725	41	700	NOT AVAILABLE					
45	3150	38	700						
50	3925	35	1000						
60	4950	27	1000						

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE WEIGHT:

2.75 INCH FFAR: 20.78 LBS

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(182-1)

Figure 2-89 (U) (Sheet 1 of 4)

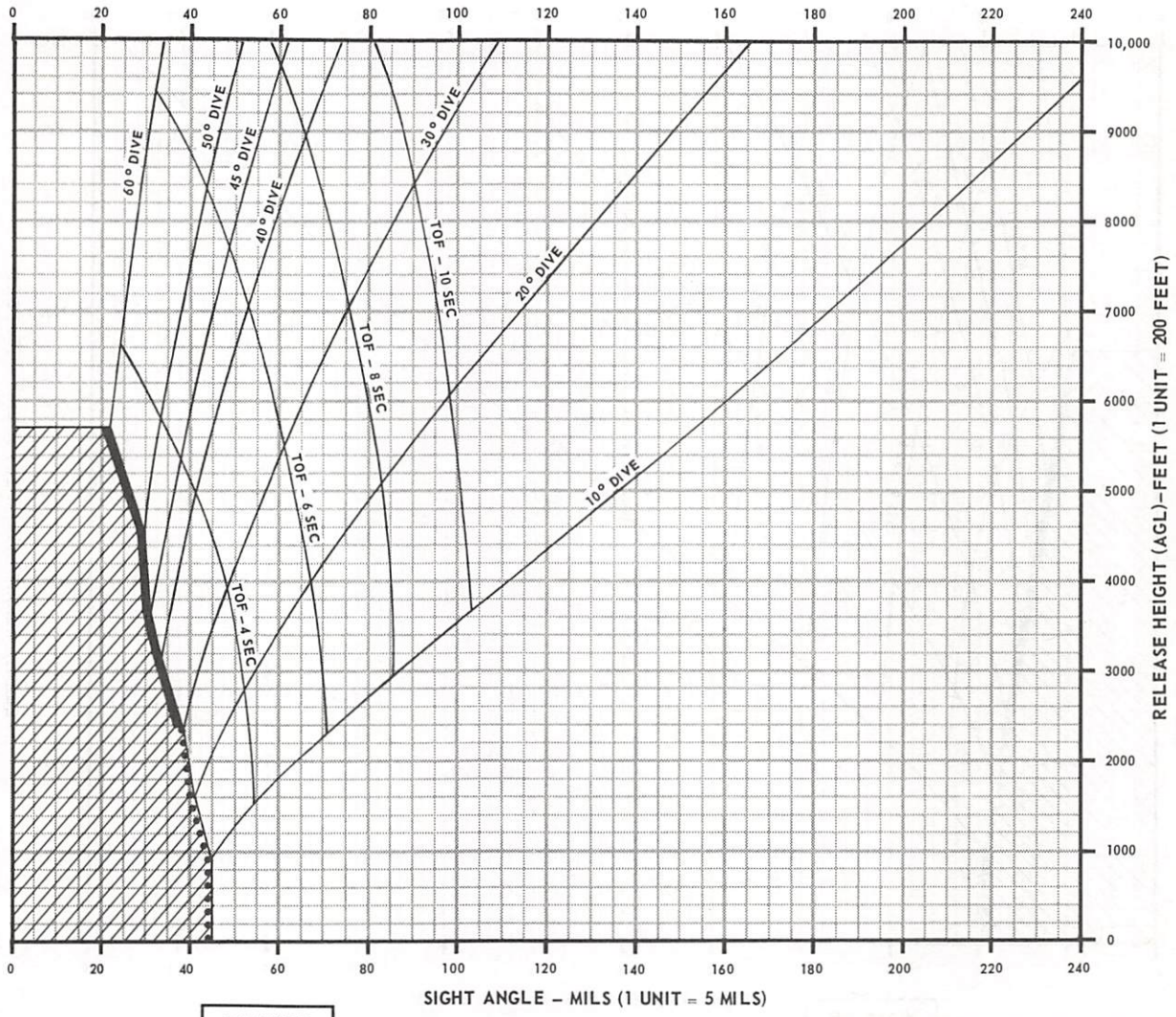
SIGHT ANGLE

2.75 INCH FFAR WITH M151 WARHEAD

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	900	45	575						
20	1600	42	775						
30	2300	39	775						
FRAG / TERRAIN 40	3125	34	700	NOT AVAILABLE					
45	3650	32	700						
50	4525	30	1000						
60	5750	22	1000						

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE WEIGHT:
2.75 INCH FFAR: 20.78 LBS

UNCLASSIFIED

FDB-1T-(182-2)

Figure 2-89 (U) (Sheet 2 of 4)

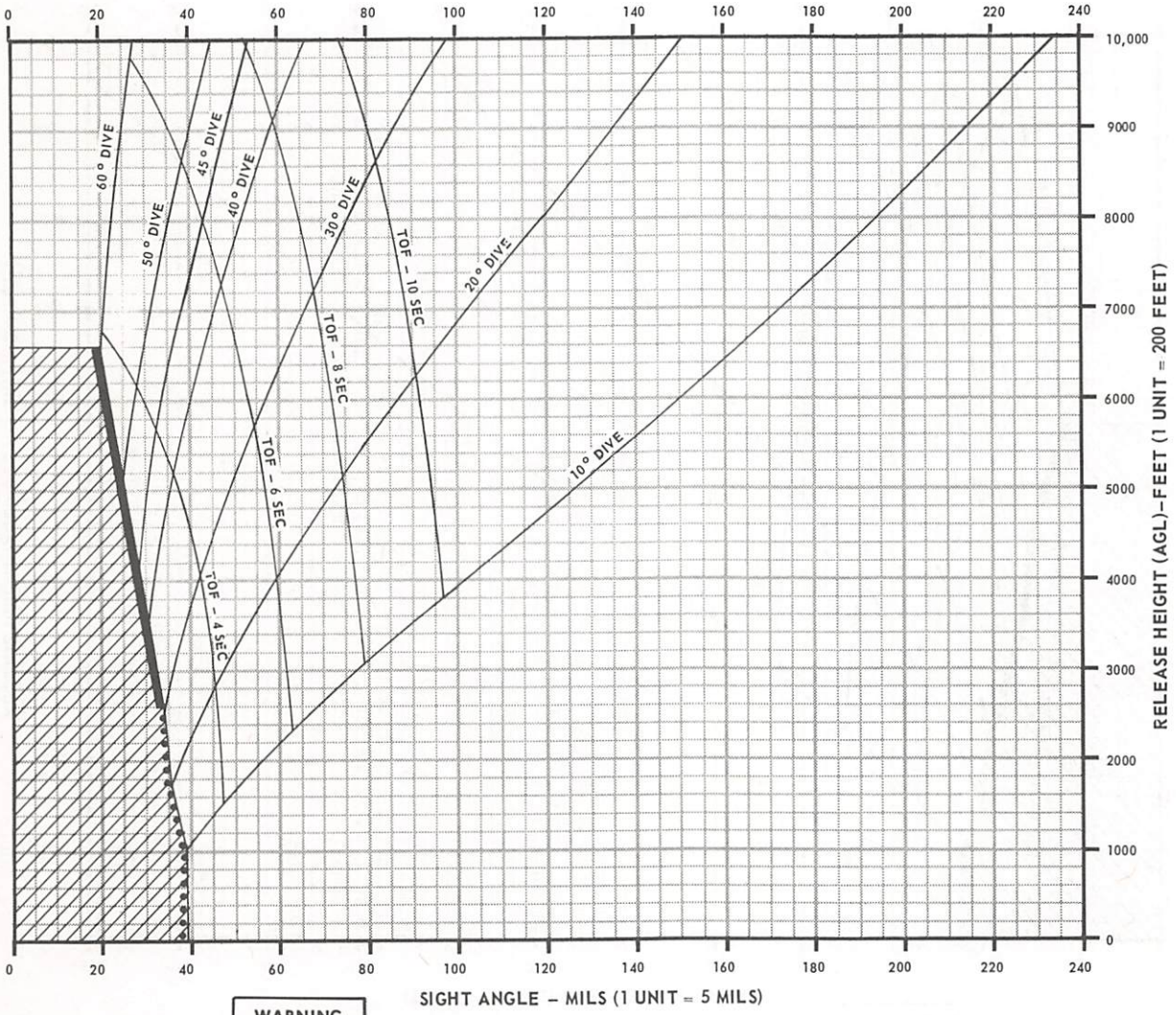
SIGHT ANGLE

2.75 INCH FFAR WITH M151 WARHEAD

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL									
DIVE ANGLE (DEG)	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0				NOT AVAILABLE					
10	1000	39	650						
20	1700	36	750						
30	2500	34	700						
40	3550	31	700						
45	4175	28	700						
50	5125	26	1000						
60	6600	20	1000						

FRAG
TERRAIN

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE WEIGHT:
2.75 INCH FFAR: 20.78 INCH

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(182-3)

Figure 2-89 (U) (Sheet 3 of 4)

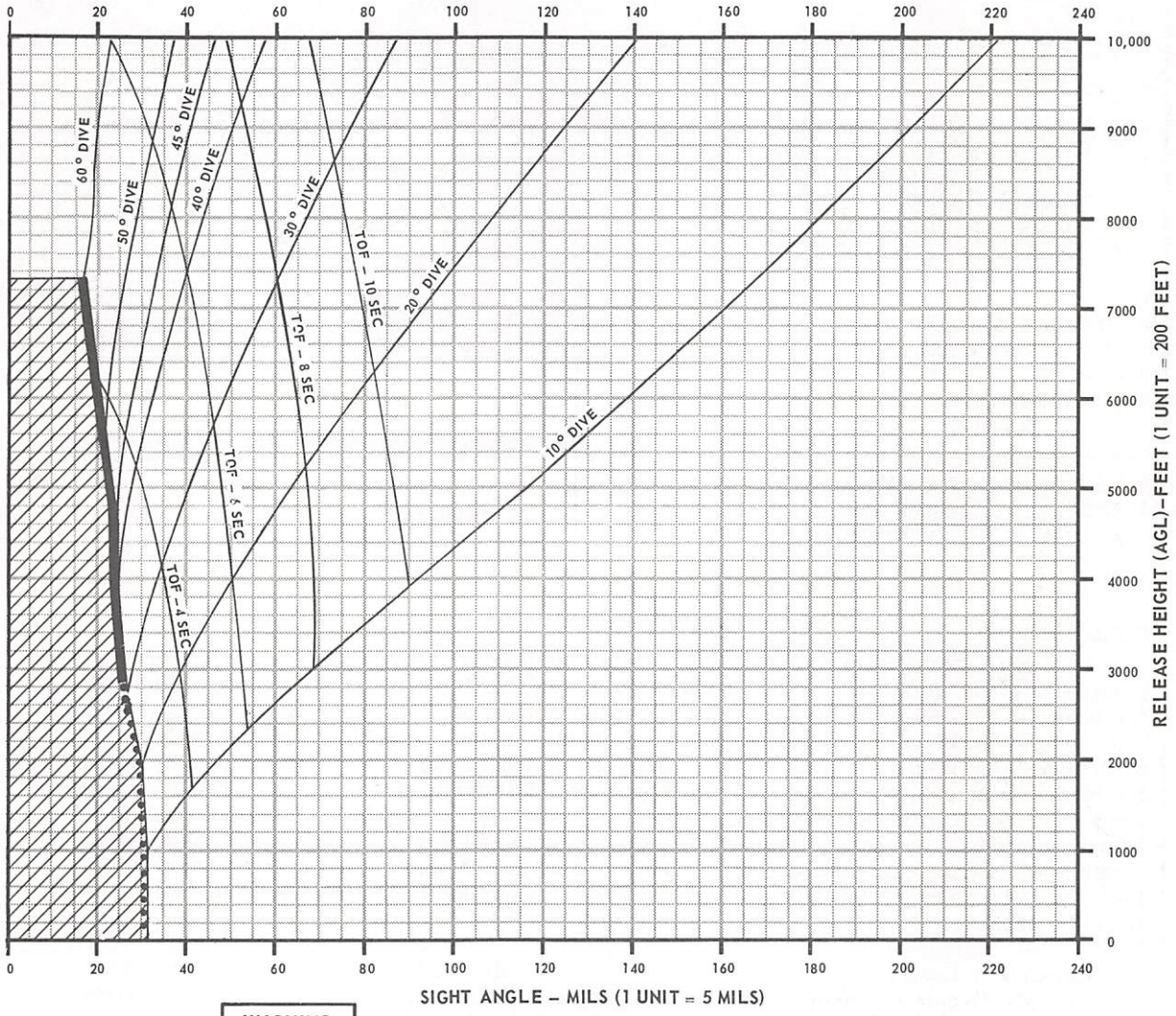
SIGHT ANGLE

2.75 INCH FFAR WITH M151 WARHEAD

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
0									
10	1000	32	600						
20	1900	31	800						
30	2600	27	550						
FRAG / TERRAIN 40	3975	25	700	NOT AVAILABLE					
45	4675	25	700						
50	5725	23	1000						
60	7350	18	1000						

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

WEAPON BALLISTIC REFERENCE WEIGHT
2.75 INCH FFAR: 20.78 LBS

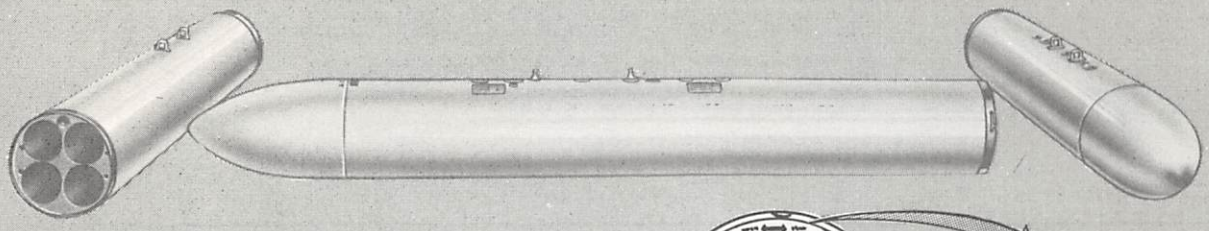
UNCLASSIFIED

FDB-1T-(182-4)

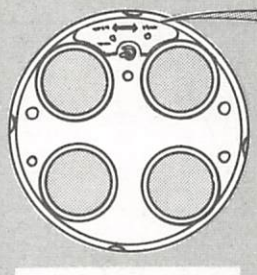
Figure 2-89 (U) (Sheet 4 of 4)

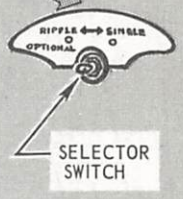
LAU-10A/A ROCKET LAUNCHER

4-5.0 INCH ZUNI



OD-153



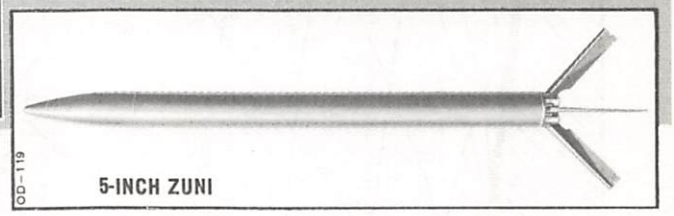


SELECTOR SWITCH

LAU-10 AFT BULKHEAD AND SELECTOR SWITCH

LENGTH	11 FEET, 8 INCHES
DIAMETER	13.9 INCHES
CAPACITY (5-INCH FFAR)	4
WEIGHT *	
FIRING RATE (RIPPLE)	95 MILLISECONDS
(SINGLE)	OPTIONAL

* FOR THE WEIGHT OF THE VARIOUS ROCKET LAUNCHER / WARHEAD / FUZE CONFIGURATIONS, REFER TO DRAG INDEX AND WEIGHT, APPENDIX A



OD-119

5-INCH ZUNI

DESCRIPTION

The LAU-10/A launcher is a reusable unit containing four 5.0 inch folding fin ZUNI rockets. The package is made up of one center section and two frangible fairings, one attached to each end of the launcher. These frangible fairings are shattered when the rockets are fired. Rocket firing is accomplished by an intervalometer mounted inside the center section. The intervalometer is so designed that a single or ripple firing sequence may be obtained from the package by setting the launcher intervalometer fire selector toggle switch to the desired position. This switch is located on the aft bulkhead of the launcher and must be positioned prior to installation of the aft frangible fairing. The package center section contains electrical receptacles for connection of airplane wiring and suspenstion lugs 14 inches and 30 inches apart which provide attachment of launcher to bomb rack. Suspension lugs not used for a particular installation should be removed from the package.

The launcher is fired by depressing the bomb button located on the pilot's control stick. The launcher will fire at approximately 65 millisecond intervals. It is necessary to keep the firing circuit energized for 0.5 second to ensure complete fire out on ripple firing.

REFERENCES

1. 5-Inch FFAR Zuni Rocket . . . . . (NAVAIR 11-85-5)
2. Rocket Assemblies . . . . . (NAVAIR 11-85-5)
3. External Store Limitations . . . . . Appendix A
4. Fuzing and Fuze Limitations. . . . . Section II, Part 1
5. Loading Procedures, Arming Wire Configuration, and Suspension Equipment. . . . . NAVAIR 01-245FDB-75
6. Current AAB's.
7. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-12.1

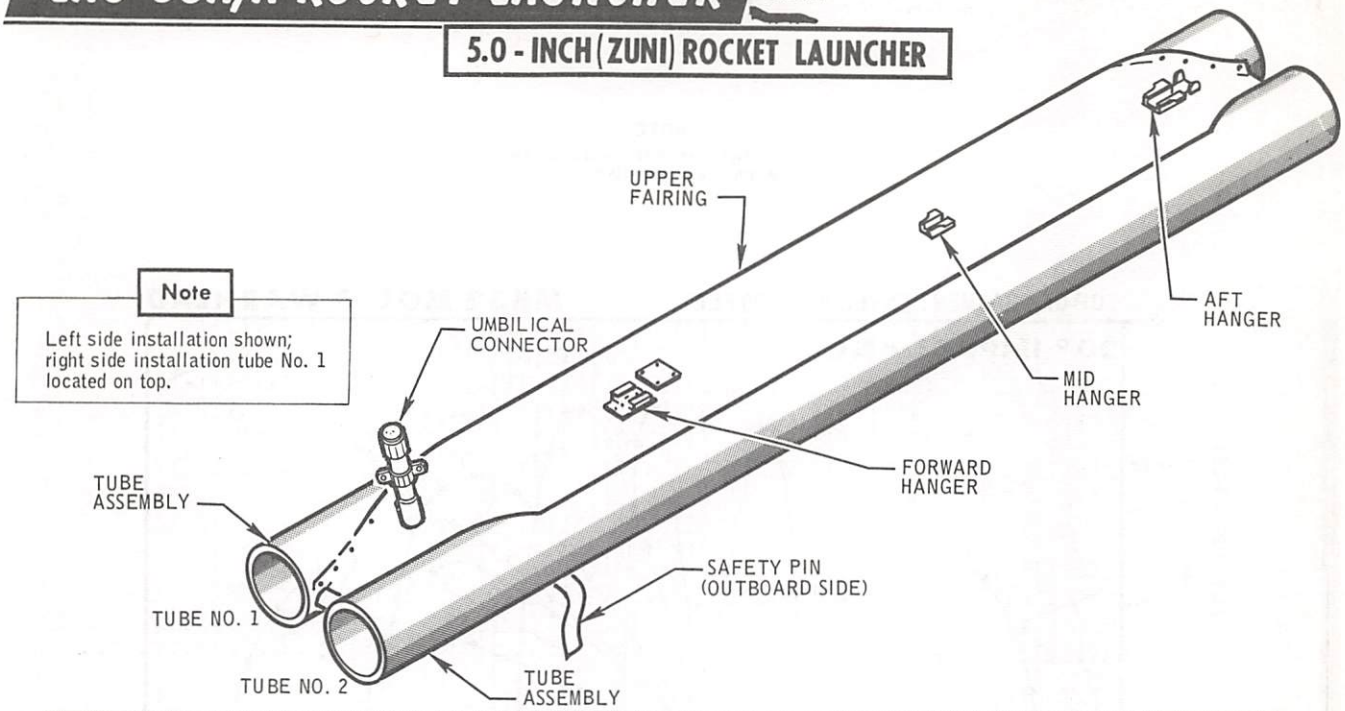
UNCLASSIFIED

FDB-1T-(183-1)

Figure 2-90 (U) (Sheet 1 of 10)

LAU-33A/A ROCKET LAUNCHER

5.0 - INCH (ZUNI) ROCKET LAUNCHER



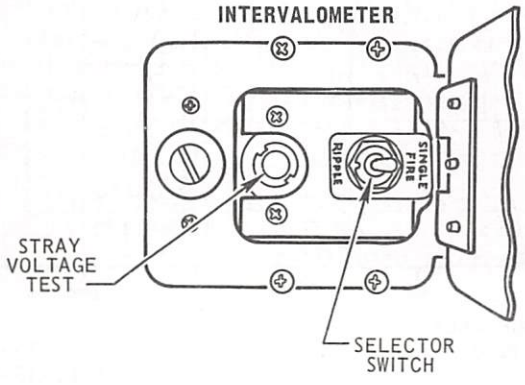
Note

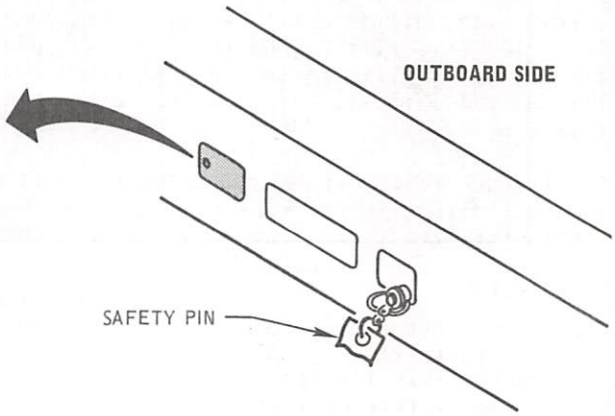
Left side installation shown; right side installation tube No. 1 located on top.

CHARACTERISTICS

WEIGHT *	
LENGTH	99.2 INCHES
WIDTH	13 INCHES
HEIGHT	7 INCHES
CAPACITY	2 EA. 5.0 INCH ZUNI ROCKETS
SUSPENSION	AERO 3A OR LAU-7/A-1 MISSILE LAUNCHER

*FOR THE WEIGHT OF THE VARIOUS ROCKET LAUNCHER/WARHEAD/FUZE CONFIGURATIONS, REFER TO DRAG INDEX AND WEIGHT, APPENDIX A





DESCRIPTION

The LAU-33A/A rocket launcher is a reusable rocket launcher used to carry and launch two 5.0-inch Zuni rockets. Three hangers secured to the launcher fairing are used to attach the LAU-33A/A launcher to either the Aero 3A or LAU-7/A-1 missile launcher. The Zuni rocket is fired by using the AIM-9 missile launch procedure. Only SINGLE FIRE is authorized.

UNCLASSIFIED

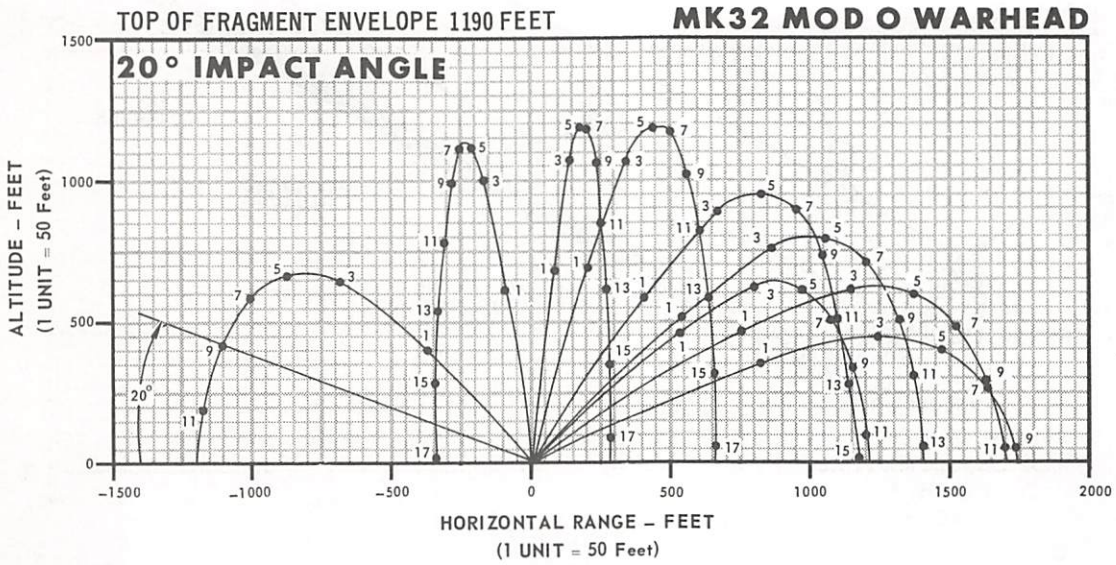
FDB-1T-(183-2)

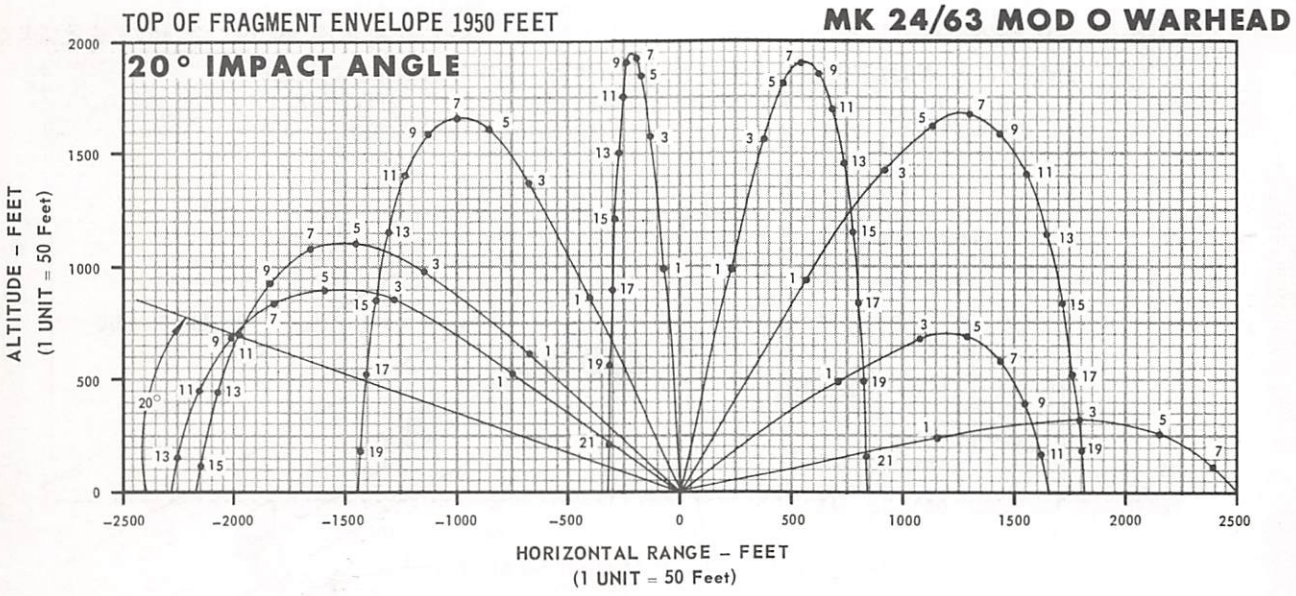
Figure 2-90 (U) (Sheet 2 of 10)

MAXIMUM FRAGMENT ENVELOPE
5 INCH ZUNI

NOTE

FRAGMENT TIME IN SECONDS IS GIVEN ADJACENT TO EACH POINT





NEW NEW NEW NEW NEW NEW NEW NEW NEW NEW

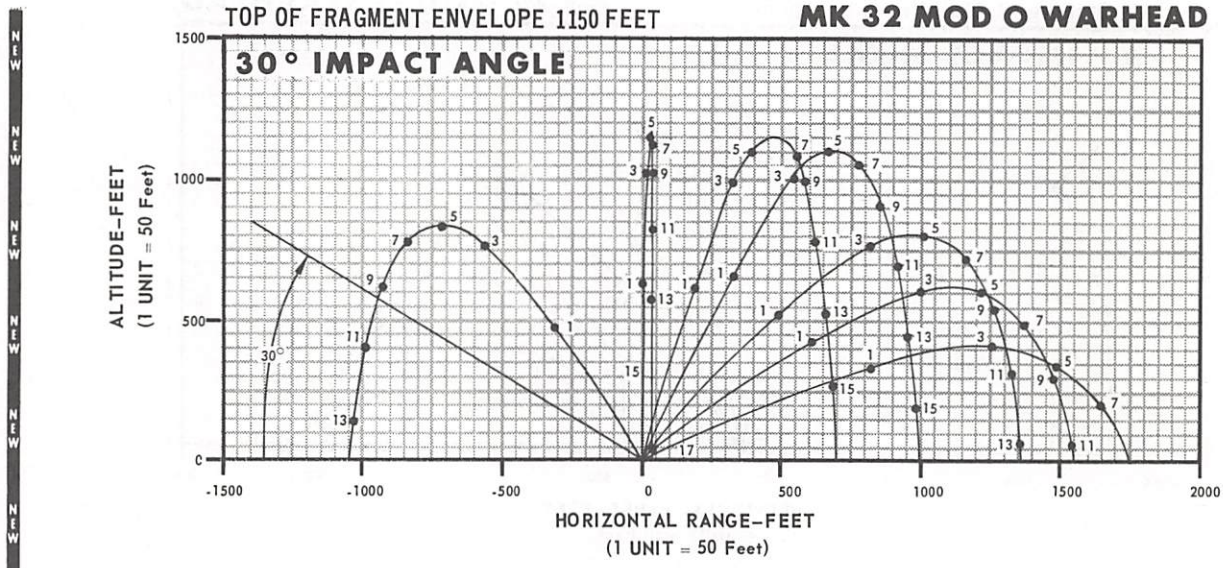
UNCLASSIFIED

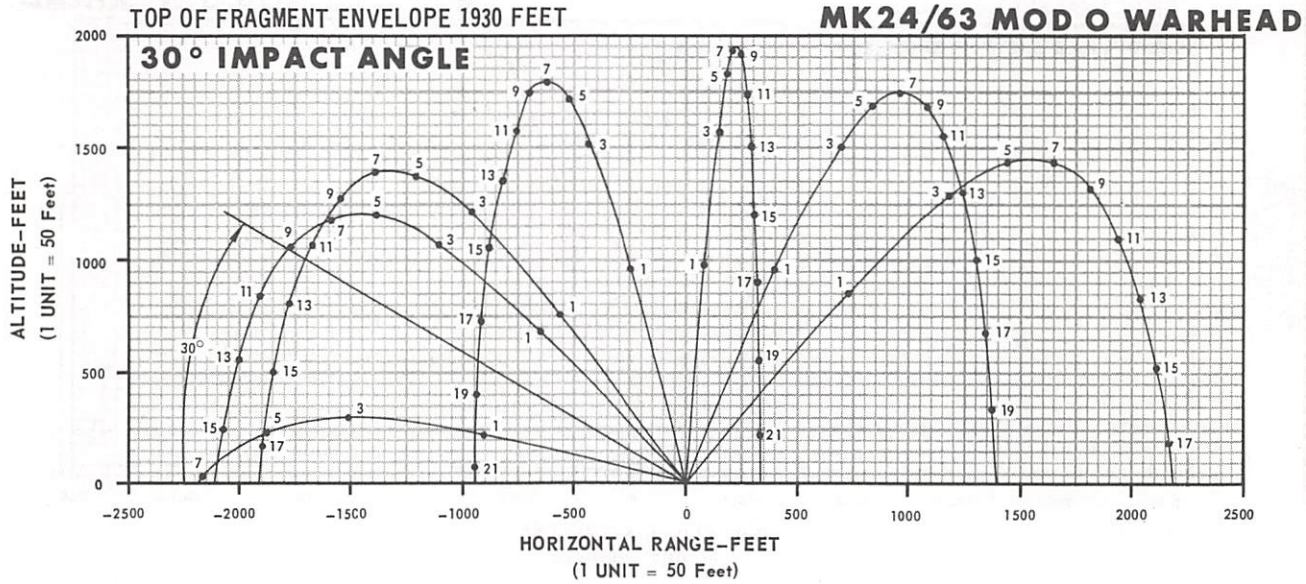
FDB-1T-(183-6)

Figure 2-90 (U) (Sheet 3 of 10)

MAXIMUM FRAGMENT ENVELOPE
5-INCH ZUNI

NOTE
FRAGMENT TIME IN SECONDS IS GIVEN ADJACENT TO EACH POINT





UNCLASSIFIED

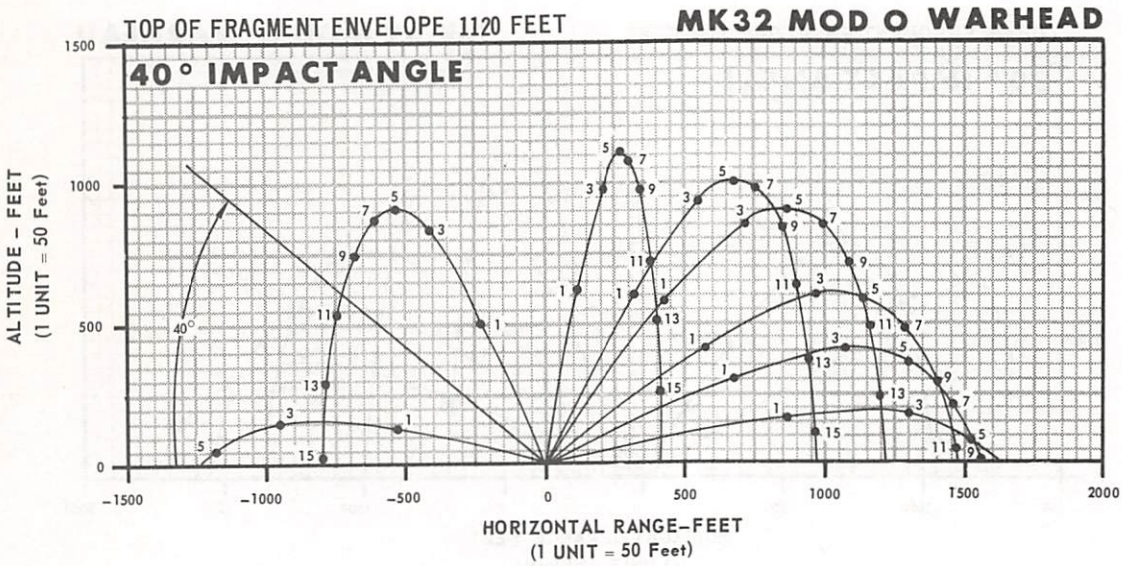
FDB-1T-(183-7)

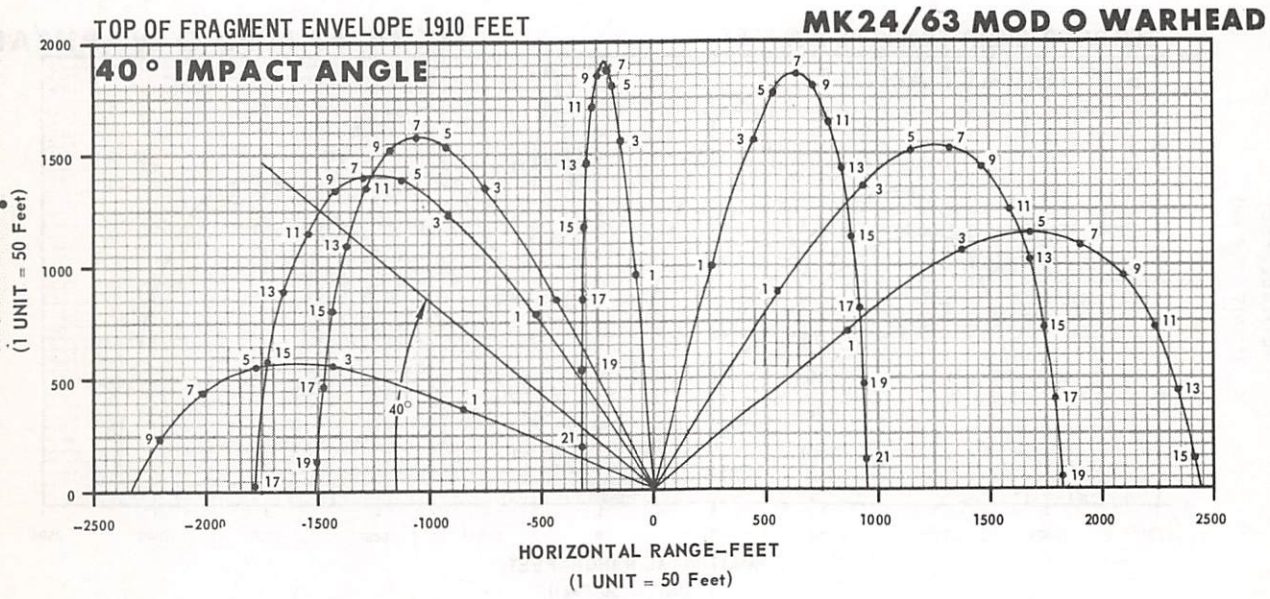
Figure 2-90 (U) (Sheet 4 of 10)

MAXIMUM FRAGMENT ENVELOPE
5 INCH ZUNI

NOTE

FRAGMENT TIME IN SECONDS IS GIVEN ADJACENT TO EACH POINT





UNCLASSIFIED

FDB–1T–(183–8)

Figure 2-90 (U) (Sheet 5 of 10)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

5-INCH ZUNI ROCKET

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
10°	2000	450	17.3	-17.6	- 80	71	105	-170	46.1	-48.4	9.7	80	1.7	79	8.1
	3000	450	29.9	-30.2	-120	113	233	-352	59.1	-61.7	13.5	127	2.1	124	9.2
20°	3000	450	7.1	- 7.3	- 18	17	24	- 31	22.1	-22.7	8.2	63	2.8	63	7.7
	4000	450	11.5	-11.7	- 27	26	47	- 62	28.3	-29.0	10.7	89	3.1	88	8.2
30°	3400	450	3.2	- 3.3	- 6	5	7	- 9	12.6	-12.8	6.6	48	3.8	49	7.4
	4000	450	4.2	- 4.3	- 7	7	11	- 13	14.7	-14.9	7.7	58	3.9	58	7.5
	5000	500	5.6	- 5.7	- 10	9	17	- 20	18.1	-18.4	9.6	73	4.0	73	7.6
45°	5000	450	2.1	- 2.1	- 3	2	5	- 5	9.6	- 9.7	6.9	51	5.3	51	7.4
	6000	500	2.5	- 2.6	- 3	3	7	- 7	11.5	-11.6	8.3	61	5.3	61	7.3
60°	7000	500	1.4	- 1.4	- 1	1	4	- 4	9.1	- 9.2	8.0	58	6.3	58	7.2

UNCLASSIFIED

FDB-1T-(183-9)

Figure 2-90 (U) (Sheet 6 of 10)

SIGHT ANGLE

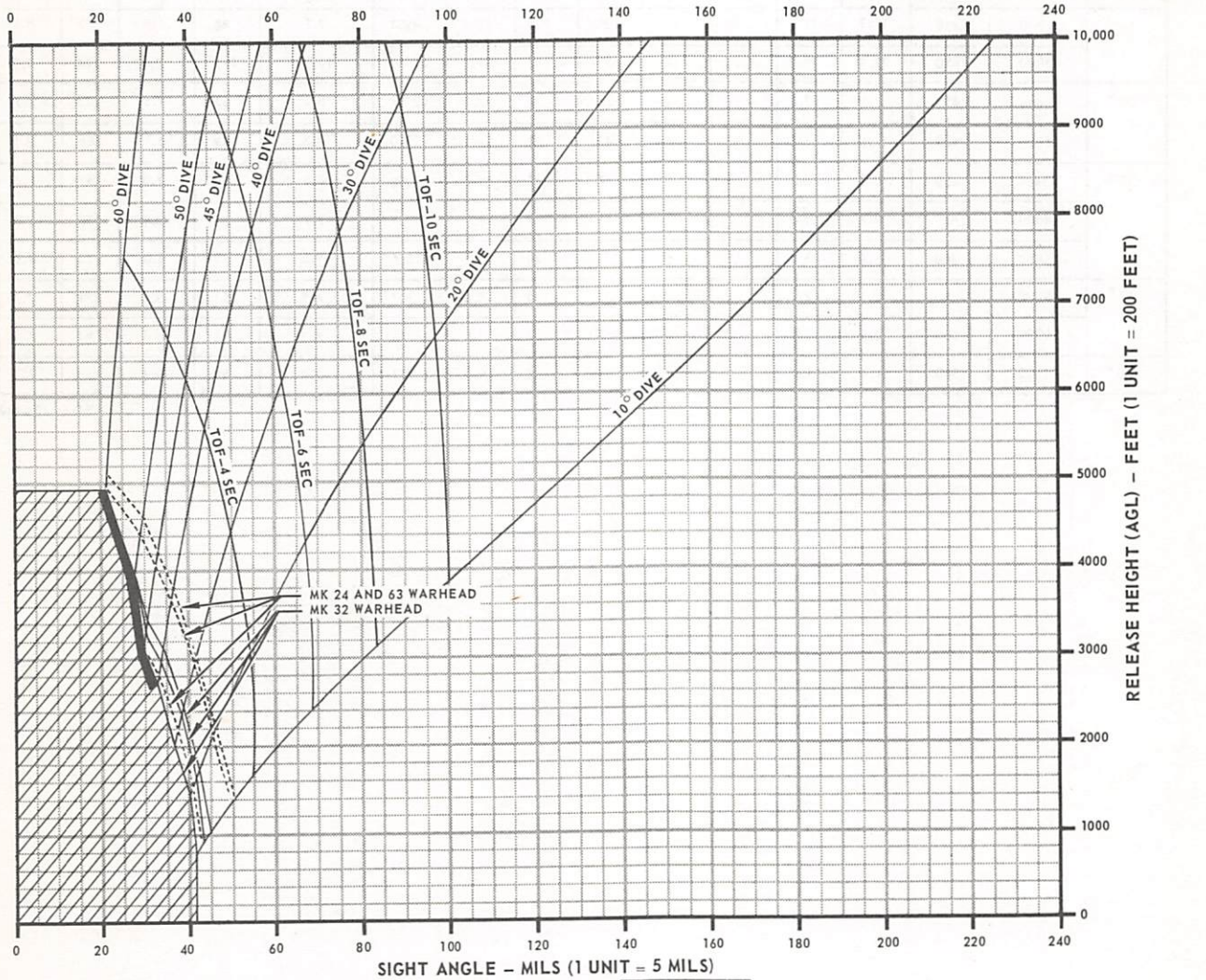
5.0-INCH ZUNI WITH MK24, MK32 AND MK63 WARHEADS

400 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).
- FOR MK 63 WARHEAD, ADD 7 MILS TO SIGHT ANGLE.

WEAPON BALLISTIC REFERENCE WEIGHT:
5.0 INCH ZUNI;
MK 24/32 – 108.8 LBS
MK 63 – 122.0 LBS



WARNING **MK 24 AND 63 WARHEADS**

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVELS (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1400	51	1125	1325	50	1050	875	44	600
20	2200	46	1500	2175	46	1475	1525	41	825
30	3000	42	1725	2975	42	1700	2200	38	925
40	3800	37	1775	3700	37	1675	2825	33	800
45	4200	34	1750	4050	33	1600	3150	31	700
50	4600	30	1675	4425	30	1500	3925	28	1000
60	5100	23	1150	4975	22	1025	4950	22	1000

FRAG
TERRAIN

WARNING **MK 32 WARHEAD**

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1000	45	725	900	44	625	775	42	500
20	1700	43	1000	1625	42	925	1375	40	675
30	2400	39	1125	2350	39	1075	2025	37	750
40	3100	34	1075	2975	34	950	2725	33	700
45	3400	31	950	3225	31	775	3150	31	700
50	3925	28	1000	3925	28	1000	3925	28	1000
60	4950	22	1000	4950	22	1000	4950	22	1000

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(183-10)

Figure 2-90 (U) (Sheet 7 of 10)

SIGHT ANGLE

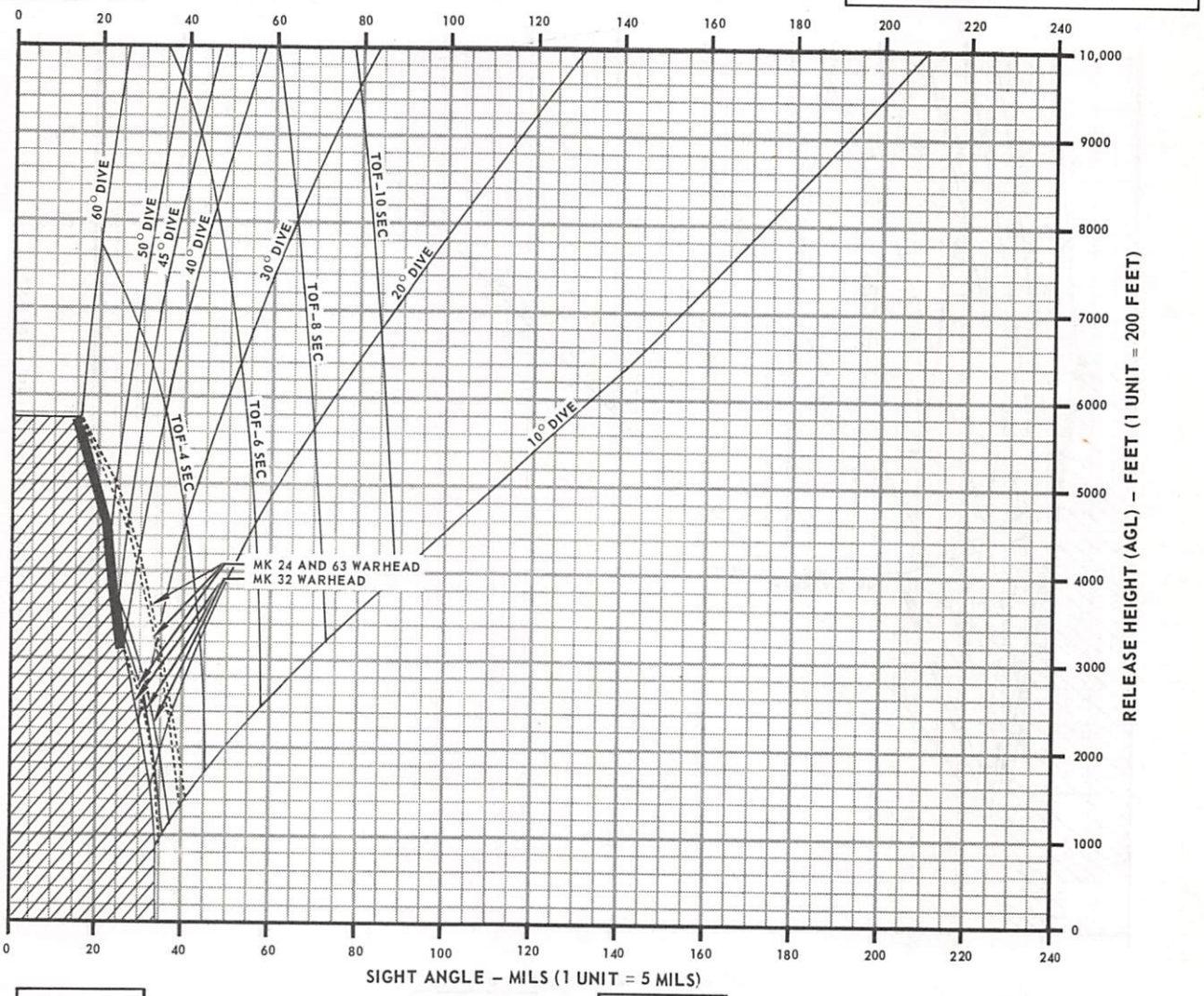
5.0-INCH ZUNI WITH MK24, MK32 AND MK63 WARHEADS

450 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).
- FOR MK 63 WARHEAD, ADD 7 MILS TO SIGHT ANGLE.

WEAPON BALLISTIC REFERENCE WEIGHT:
5.0 INCH ZUNI;
MK 24/32 – 108.8 LBS
MK 63 – 122.0 LBS



WARNING MK 24 AND 63 WARHEADS

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVELS (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1400	41	1075	1325	40	1000	900	35	575
20	2400	39	1575	2275	38	1450	1725	34	900
30	3200	34	1675	3175	34	1650	2475	31	950
40	4200	30	1775	4075	30	1650	3150	27	725
45	4600	27	1650	4500	27	1550	3650	25	700
50	5000	25	1475	4825	23	1300	4525	23	1000
60	5750	17	1000	5750	17	1000	5750	17	1000

NEW NEW NEW FRAG TERRAIN

WARNING MK 32 WARHEAD

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVELS (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV ERY
10	1100	37	775	1000	36	675	875	35	550
20	1900	35	1075	1725	34	900	1550	33	725
30	2700	32	1175	2525	31	1000	2250	30	725
40	3400	27	975	3225	27	800	3125	27	700
45	3700	25	750	3650	25	700	3650	25	700
50	4525	23	1000	4525	23	1000	4525	23	1000
60	5750	17	1000	5750	17	1000	5750	17	1000

UNCLASSIFIED

FDB–1T–(183–11)

Figure 2-90 (U) (Sheet 8 of 10)

SIGHT ANGLE

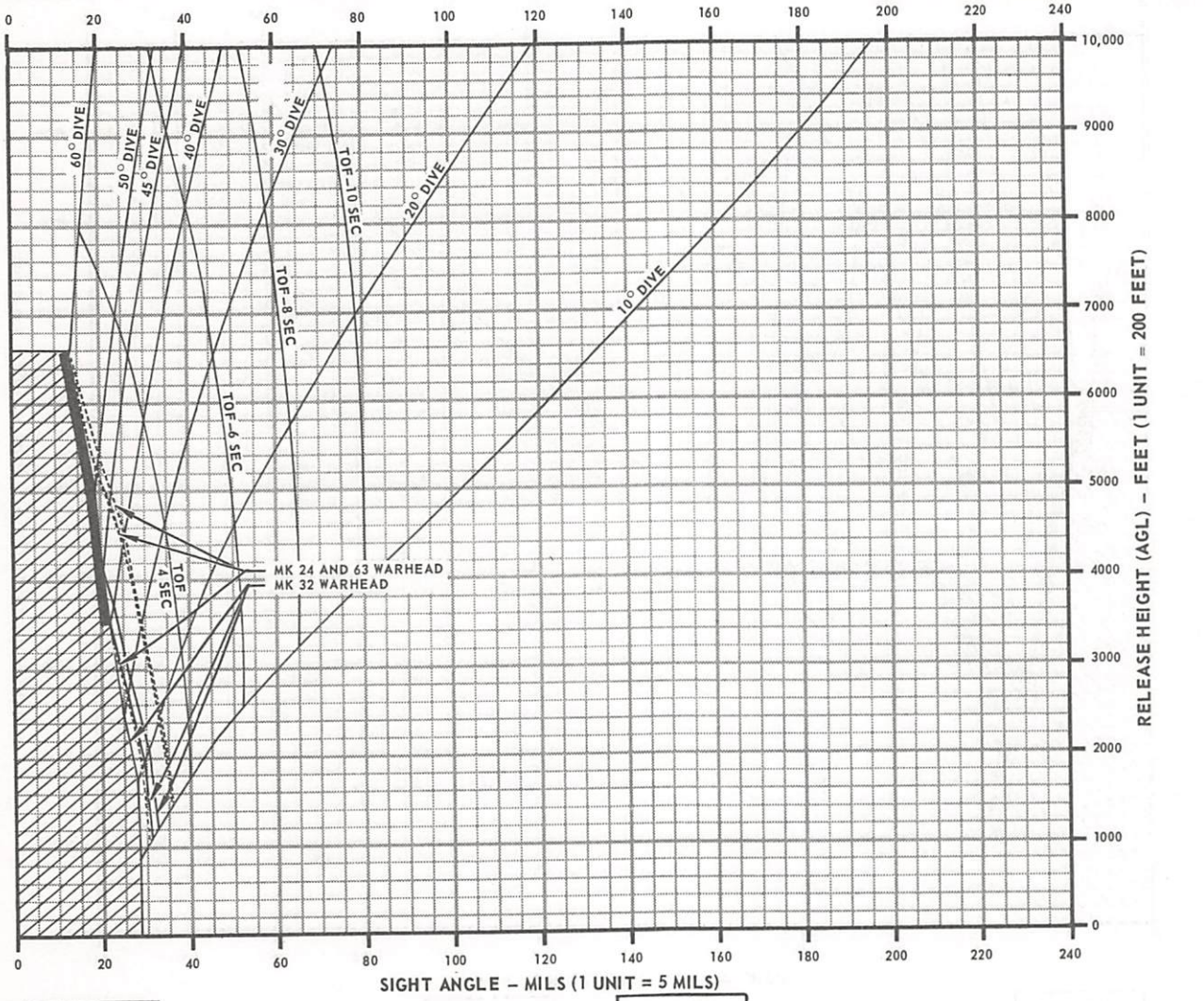
5.0-INCH ZUNI WITH MK24, MK32 AND MK63 WARHEADS

500 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED I MEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).
- FOR MK 63 WARHEAD, ADD 7 MILS TO SIGHT ANGLE.

WEAPON BALLISTIC REFERENCE WEIGHT:
5.0 INCH ZUNI;
MK 24/32 – 108.8 LBS
MK 63 – 122.0 LBS



WARNING

MK 24 AND 63 WARHEADS

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVELS (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1500	36	1150	1450	36	1100	1025	31	675
20	2500	33	1550	2475	33	1525	1850	29	900
30	3500	30	1700	3450	29	1650	2725	27	925
40	4600	26	1750	4450	26	1600	3550	24	700
45	5000	23	1525	4850	23	1375	4175	21	700
FRAG 50	5400	20	1275	5225	20	1100	5125	20	1000
TERRAIN 60	6600	15	1000	6600	15	1000	6600	15	1000

WARNING

MK 32 WARHEAD

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVELS (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1200	33	850	1050	31	700	875	28	525
20	2100	31	1150	1900	29	950	1775	28	825
30	2900	27	1100	2750	27	950	2500	26	700
40	3700	24	850	3550	24	700	3550	24	700
45	4175	21	700	4175	21	700	4175	21	700
50	5125	20	1000	5125	20	1000	5125	20	1000
60	6600	15	1000	6600	15	1000	6600	15	1000

NEW NEW NEW

UNCLASSIFIED

FDB-1T-(183-12)

Figure 2-90 (U) (Sheet 9 of 10)

SIGHT ANGLE

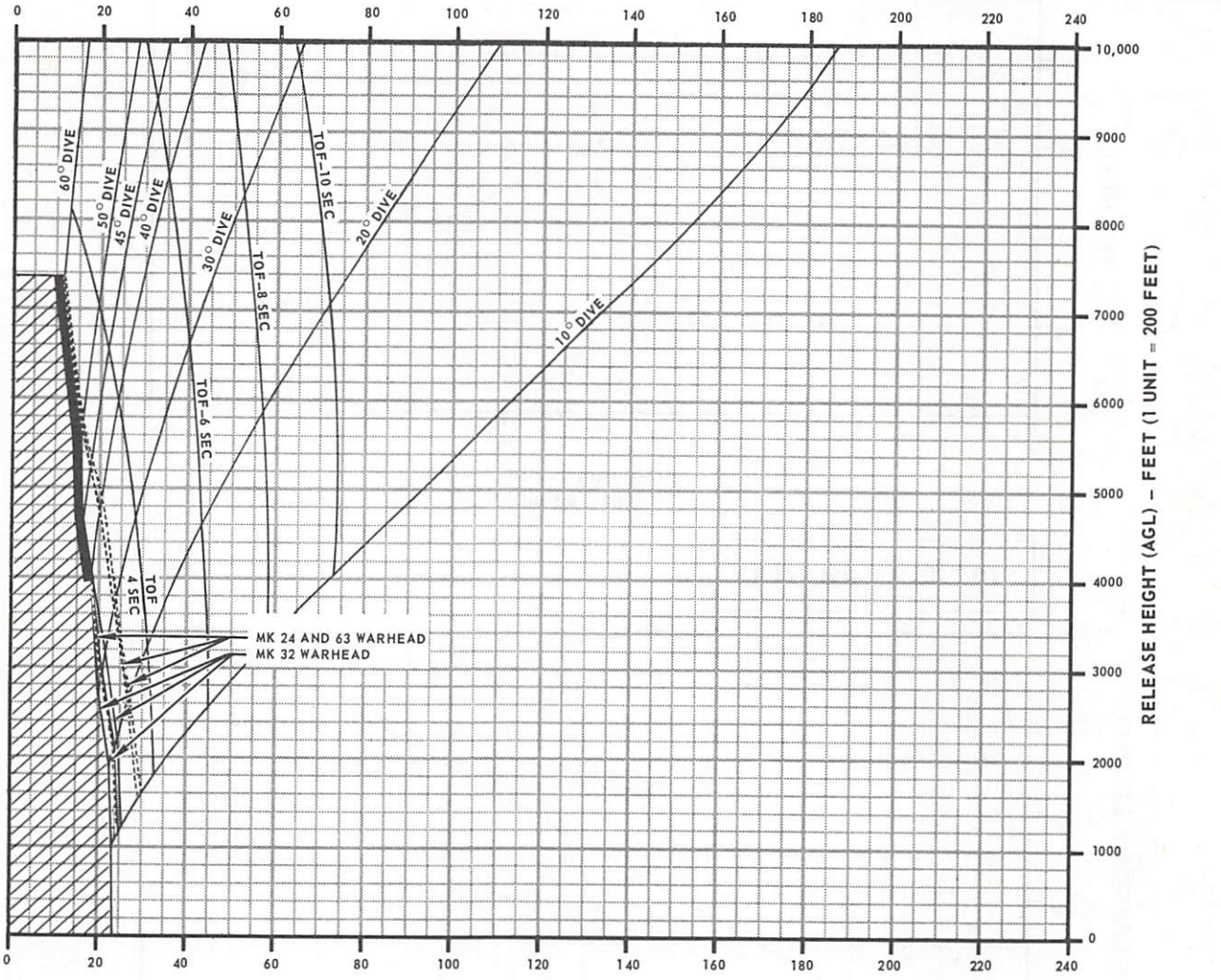
5.0-INCH ZUNI WITH MK24, MK32 AND MK63 WARHEADS

550 KTAS RELEASE

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).
- FOR MK 63 WARHEAD, ADD 7 MILS TO SIGHT ANGLE.

WEAPON BALLISTIC REFERENCE WEIGHT:
5.0 INCH ZUNI;
MK 24/32 - 108,8 LBS
MK 63 - 122.0 LBS



WARNING

MK 24 AND 63 WARHEADS

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1600	30	1200	1475	29	1075	1075	24	675
20	2700	28	1600	2675	28	1575	2050	24	950
30	3800	25	1750	3675	24	1625	2925	21	875
40	4900	21	1625	4750	21	1475	3975	19	700
45	5300	19	1325	5200	19	1225	4675	18	700
50	5800	17	1075	5725	17	1000	5725	17	1000
60	7350	13	1000	7350	13	1000	7350	13	1000

NEW NEW NEW FRAG TERRAIN

WARNING

MK 32 WARHEAD

DIVE ANGLE (DEG)	FRAGMENT HIT PROBABILITY LEVEL (Height in Feet) AGL								
	0.000			0.001			0.010		
	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY	MIN. REL.	SIGHT ANGLE	RECOV-ERY
10	1200	26	800	1125	25	725	1025	24	625
20	2200	24	1100	2025	23	925	1900	23	800
30	3200	22	1150	2950	21	900	2725	21	675
40	4000	19	725	3975	19	700	3975	19	700
45	4675	18	700	4675	18	700	4675	18	700
50	5725	17	1000	5725	17	1000	5725	17	1000
60	7350	13	1000	7350	13	1000	7350	13	1000

UNCLASSIFIED

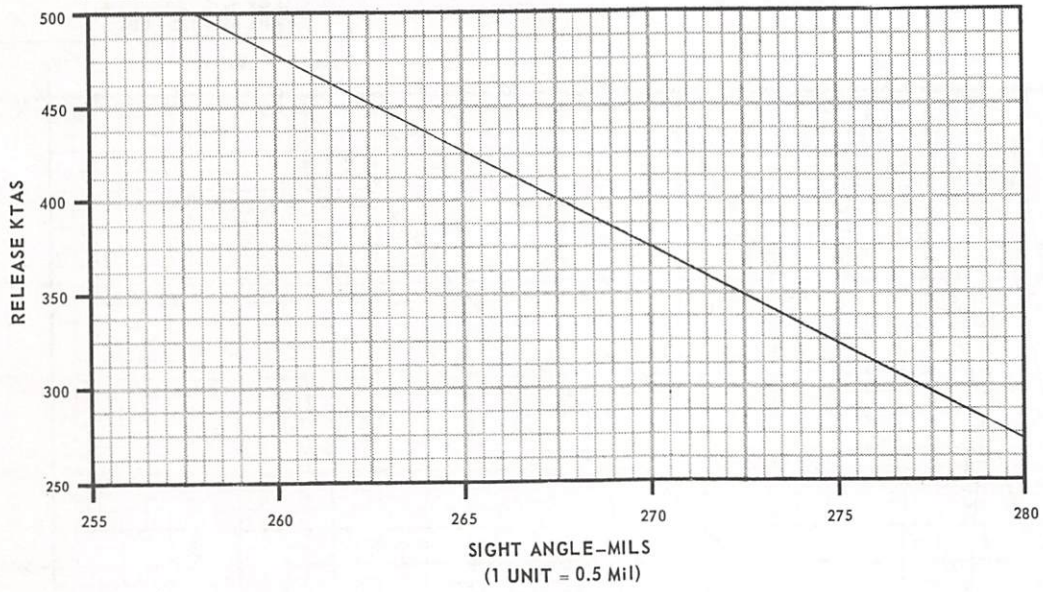
FDB-1T-(183-13)

Figure 2-90 (U) (Sheet 10 of 10)

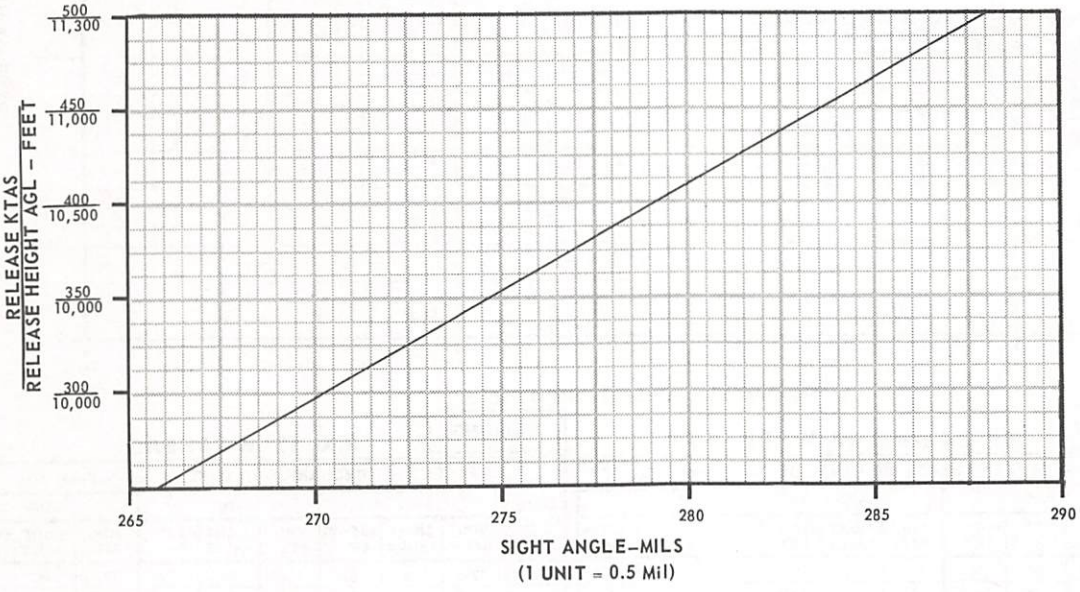
SIGHT ANGLE-ZUNI MK 33 MOD 1 FLARE

42,000 POUNDS GROSS WEIGHT

5500 FT AGL, LEVEL DELIVERY



10° DIVE DELIVERY



FDB-1T-(184-2) UNCLASSIFIED

Figure 2-91 (U) (Sheet 1 of 3)

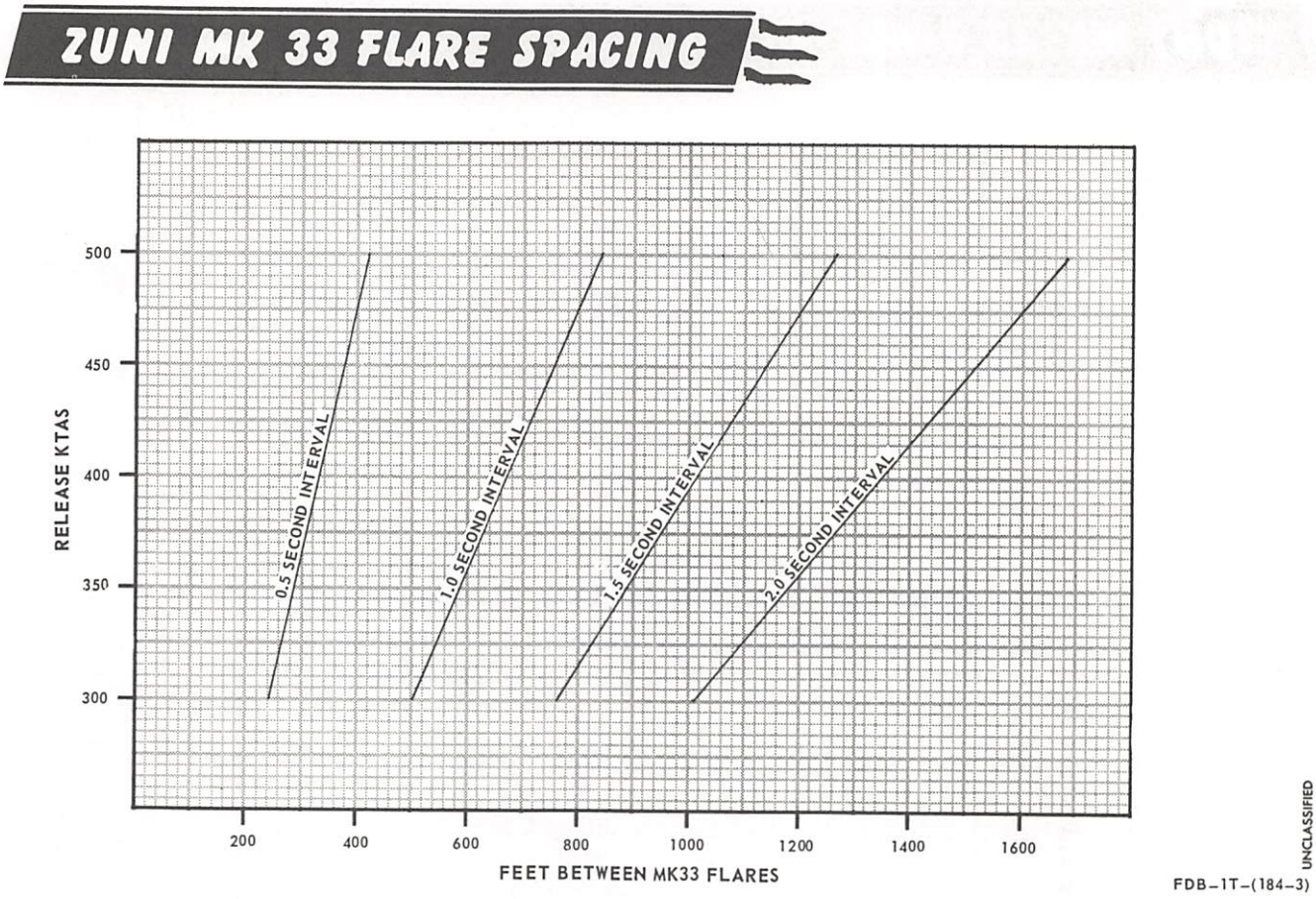
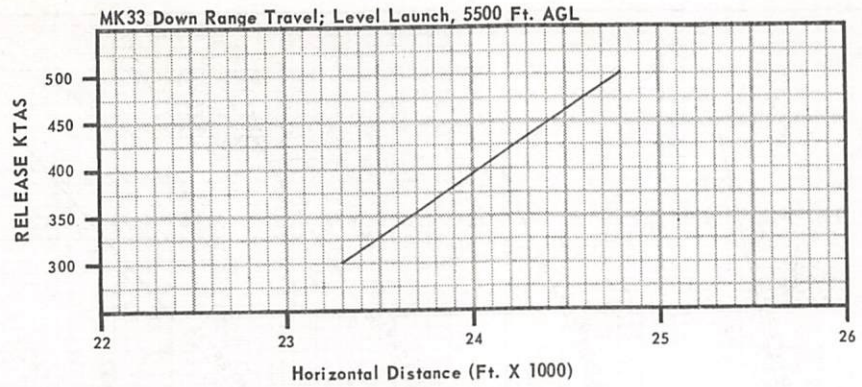
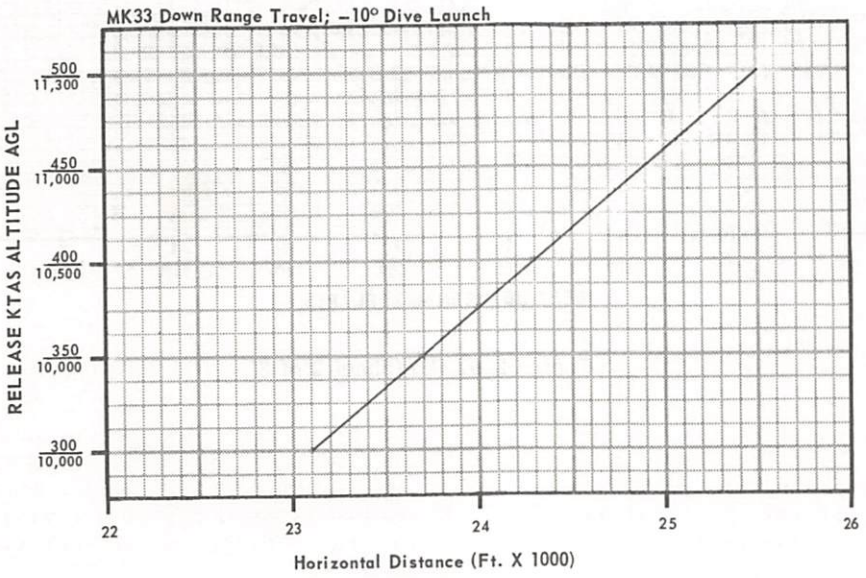
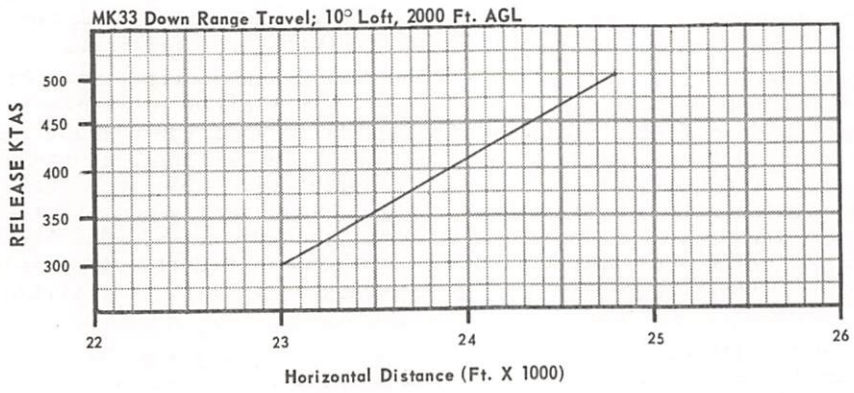


Figure 2-91 (U) (Sheet 2 of 3)

ZUNI MK 33 FLARE DOWN RANGE TRAVEL







UNCLASSIFIED

FDB-1T-(184-4)

Figure 2-91 (U) (Sheet 3 of 3)

CBU-24, -29, -49 DISPENSER

CBU-24/B =	SUU-30/B PLUS 665 BLU-26/B BOMBS	CBU-49B/B =	SUU-30B/B PLUS 665 BLU-59/B BOMBS
CBU-29/B =	SUU-30/B PLUS 665 BLU-36/B BOMBS		

CHARACTERISTICS	
WEIGHT (Loaded)	835 Pounds
LENGTH (Fuze Installed)	93 Inches
DIAMETER	16 Inches

PAINTING AND MARKING	
DISPENSER CONTAINER	Olive Drab
CBU-24B, -24A/B, -24B (Mod, -24C/B	None
-29B, -29A/B, -29B (Mod)	Yellow ring 8 Inch Diameter
-49B, -49A/B, -49B (Mod), -49CB	Solid yellow circle 8 Inch Diameter

ALL CBU's have identification stenciled on container in yellow.

DESCRIPTION

The CBU-24, -29, -49 cluster bomb unit is designed for use against personnel and light material targets. Components of the CBU-24, are the SUU-30/B dispenser, the time fuze, and the BLU-26/B bombs. The CBU-29 and CBU-49 are identical to the CBU-24 except for the bomb used. The BLU-26/B, BLU-36/B, and BLU-59/B differ in the type of fuze employed.

The SUU-30 dispenser is divided in half longitudinally. The 2 halves are locked together by a nose locking cap at the forward end and by a base plate screwed into both halves at the aft end. 14 inch suspension is used with the lugs extending through the dispenser and attaching to the bottom half of the container. A dual set of arming wire guides are positioned along the top half of the dispenser to reduce arming wire vibration. Aluminum alloy fins mounted in an (x) or (+) configuration are canted to impart spin to the dispenser when released.

At release, the arming wires are withdrawn from the time fuze and the arming and timing cycle is initiated. At the expiration of the pre-set time interval, fuze function occurs. As the fuze booster ignites, the nose locking cap is forced off, unlocking the forward end of the dispenser and forces the 2 halves apart. The BLU-26, -36, -59 bombs assume their trajectory, spin-arm, and detonate on impact.

BLU-26/36/59 bomblet fuzing is similar in operation except for the functioning delays. The fuzes are embedded in the bomblets and are armed by centrifugal force created by spinning action of the bomblet upon release into the airstream. The spin rate required to arm the fuze is reached in about 1 second after release from the dispenser. BLU-26 bomblets detonate instantaneously on impact. BLU-36 bomblets provide random delays which range from 0 to 120 minutes with about 50 percent detonating within 10 minutes after impact. BLU-59 bomblets also provide random delays which range from 0 to 30 minutes with about 50 percent detonating within 8 minutes after impact. Due to the dense concentration of bomblets at release, some detonations may occur prior to impact as a result of bomblet collisions. There is no external feature that indicates the bomblet is armed. When armed these bomblets are extremely sensitive and very dangerous to handle.

REFERENCES

1. Weapon Assembly (Description) . . . . . NAVAIR 11-5A-1
2. External Store Limitations . . . . . Appendix A
3. Fuzing and Fuze Limitations . . . . . Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment . . . NAVAIR 01-245FDB-75
5. Current AAB's.
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-14.2

CONFIDENTIAL

Figure 2-92 (C) (Sheet 1 of 22)

FDB-1T-(185-1)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

CBU-24/B, -29/B, -49/B DISPENSER AND BOMB

RELEASE PARAMETERS			ERROR SENSITIVITY (FT + LONG, - SHORT)									RELATIVE WIND-10 KNOTS				M907 FUZE SETTING
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT SLANT RANGE 1000 ft.	RANGE		CROSS		
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL		FT	MILS	FT	MILS	
10°	2000	450	80	-81	-180	170	154	-180	14.1	-14.5	5.4	186	13.0	188	34.8	4.0 SEC
	2000	500	75	-76	-190	180	172	-205	16.1	-16.6	5.7	181	11.1	180	31.6	
20°	3000	450	71	-72	-110	100	102	-115	10.6	-10.8	5.7	202	18.9	203	35.7	
	3000	500	65	-66	-110	110	107	-123	11.7	-11.9	6.0	190	16.1	192	32.0	
30°	4000	450	63	-64	-80	70	76	-84	9.0	-9.1	6.0	222	24.5	221	36.8	
	4000	500	56	-58	-80	70	77	-86	9.7	-9.8	6.2	205	21.0	203	32.8	
0°	1500	450	127	-128	-330	320	348	-437	28.2	-29.4	6.6	204	7.1	206	31.2	6.0 SEC
	1500	500	123	-124	-370	360	420	-536	33.6	-35.3	7.2	210	6.1	209	29.0	
10°	2500	450	104	-105	-160	150	176	-211	17.6	-18.0	6.7	198	11.1	198	29.5	
	2500	500	98	-99	-170	160	193	-237	20.1	-20.7	7.1	190	9.3	188	26.5	
20°	3500	450	85	-87	-100	90	107	-125	13.1	-13.3	6.8	194	14.7	194	28.5	
	3500	500	75	-77	-90	80	106	-127	14.5	-14.8	7.2	179	12.2	180	25.0	
30°	5000	450	82	-84	-70	70	93	-103	11.2	-11.4	7.5	238	21.1	238	31.7	
	5000	500	73	-75	-70	70	91	-102	12.2	-12.3	7.8	217	17.7	216	27.7	
10°	3500	450	136	-137	-150	150	217	-254	20.2	-20.6	8.5	245	12.0	247	29.0	8.0 SEC
	3500	500	129	-131	-160	150	240	-287	23.2	-23.8	9.1	237	10.1	238	26.1	
20°	5000	450	121	-123	-100	100	155	-175	15.9	-16.1	8.9	266	16.6	263	29.6	
	5000	500	111	-113	-100	100	159	-184	17.6	-17.9	9.4	245	13.8	245	26.1	
30°	6000	450	97	-100	-70	60	104	-116	13.4	-13.5	9.0	249	18.5	248	27.6	
	6000	500	83	-86	-60	60	96	-110	14.4	-14.6	9.3	222	15.3	221	23.8	

UNCLASSIFIED

FDB-1T-(185-3)

Figure 2-92 (U) (Sheet 2 of 22)

This page is UNCLASSIFIED

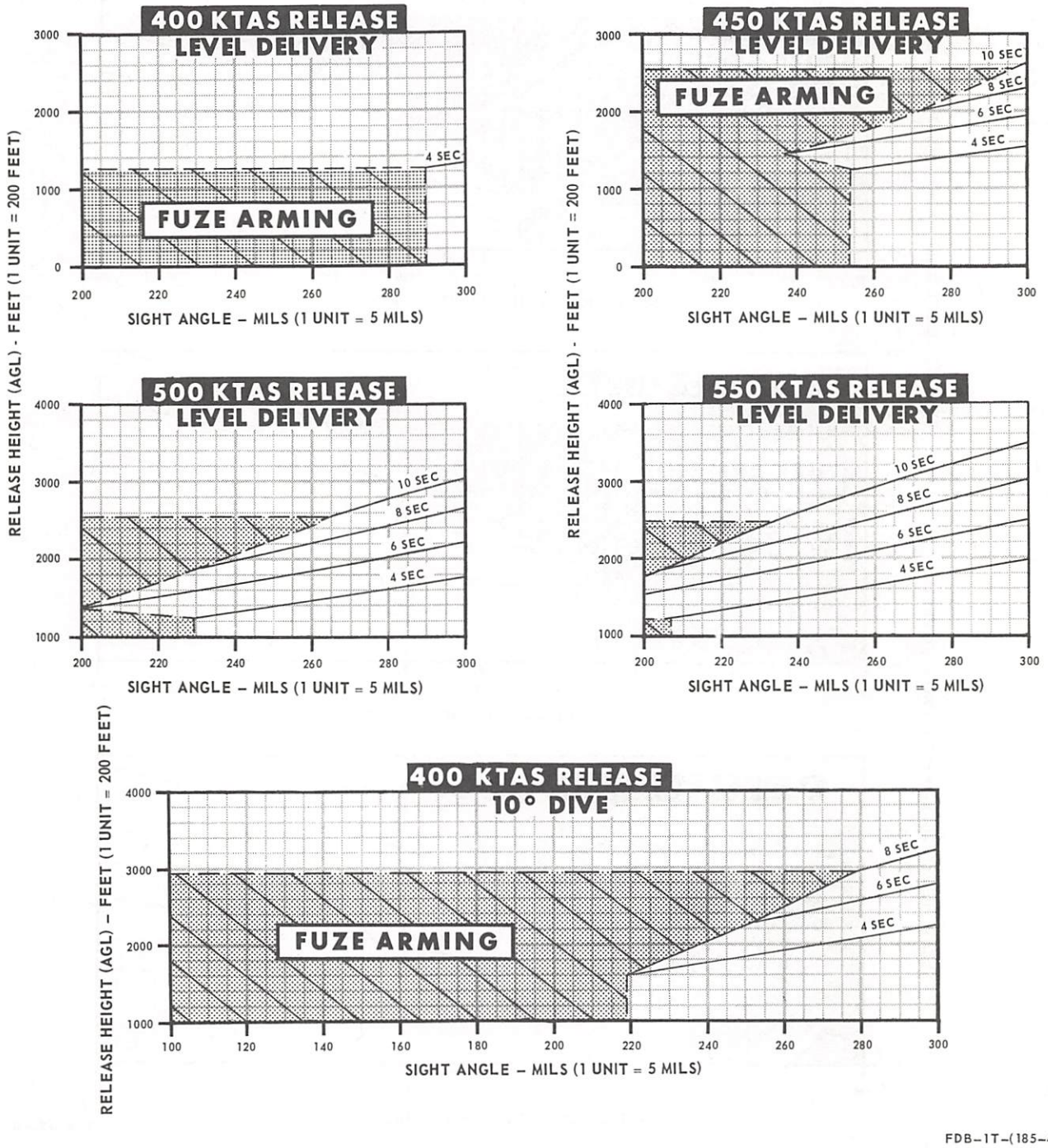
SIGHT ANGLE
CBU-24/B, -29/B -49/B DISPENSER

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.



UNCLASSIFIED

FDB-1T-(185-4)

Figure 2-92 (U) (Sheet 3 of 22)

SIGHT ANGLE
CBU-24/B, -29/B -49/B DISPENSER
10° DIVE

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.

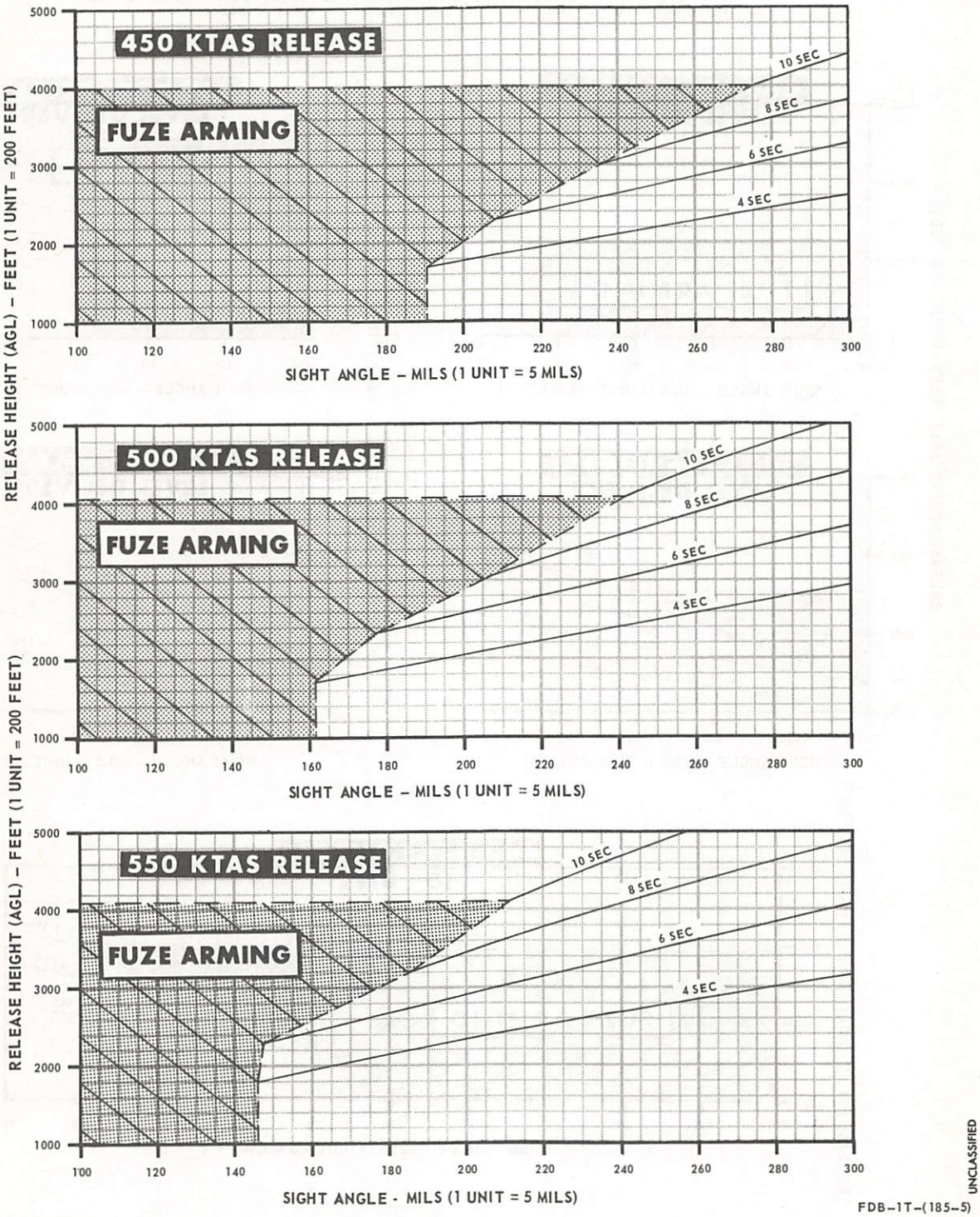


Figure 2-92 (U) (Sheet 4 of 22)

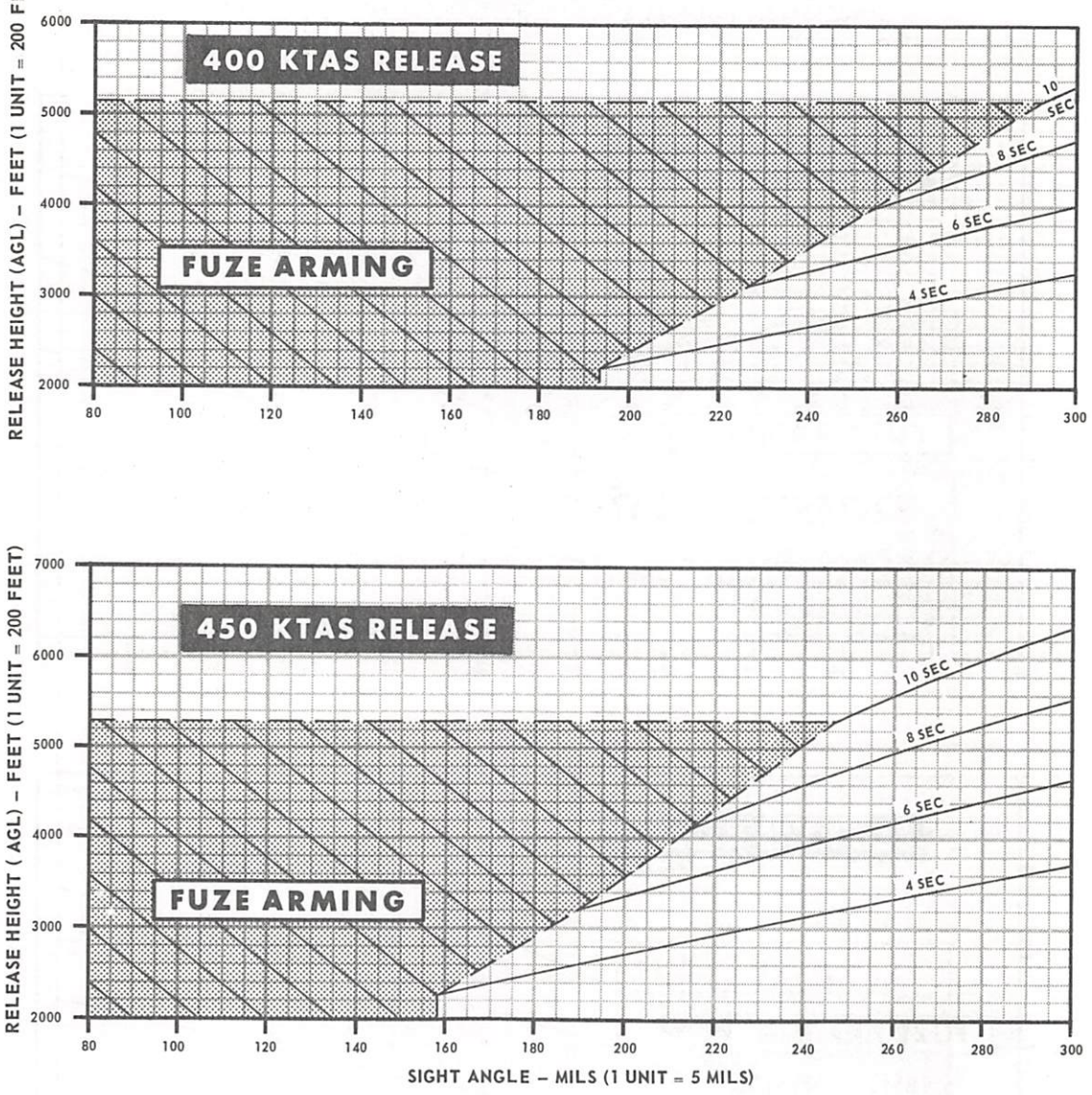
SIGHT ANGLE
CBU-24/B, -29/B-49/B DISPENSER
20° DIVE

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.



UNCLASSIFIED

FDB-1T-(185-6)

Figure 2-92 (U) (Sheet 5 of 22)

SIGHT ANGLE

CBU-24/B, -29/B -49/B DISPENSER
20° DIVE

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.

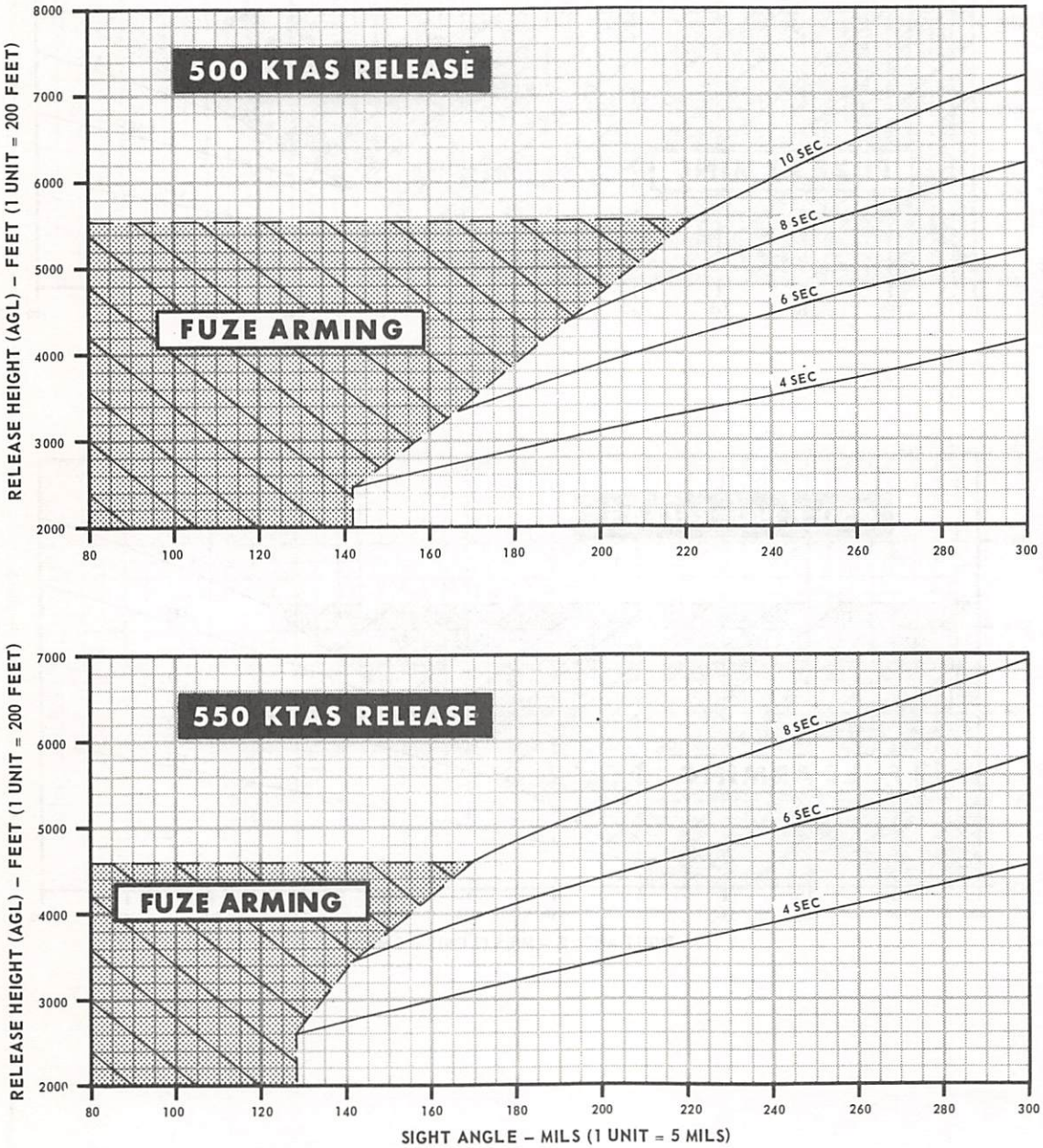


Figure 2-92 (U) (Sheet 6 of 22)

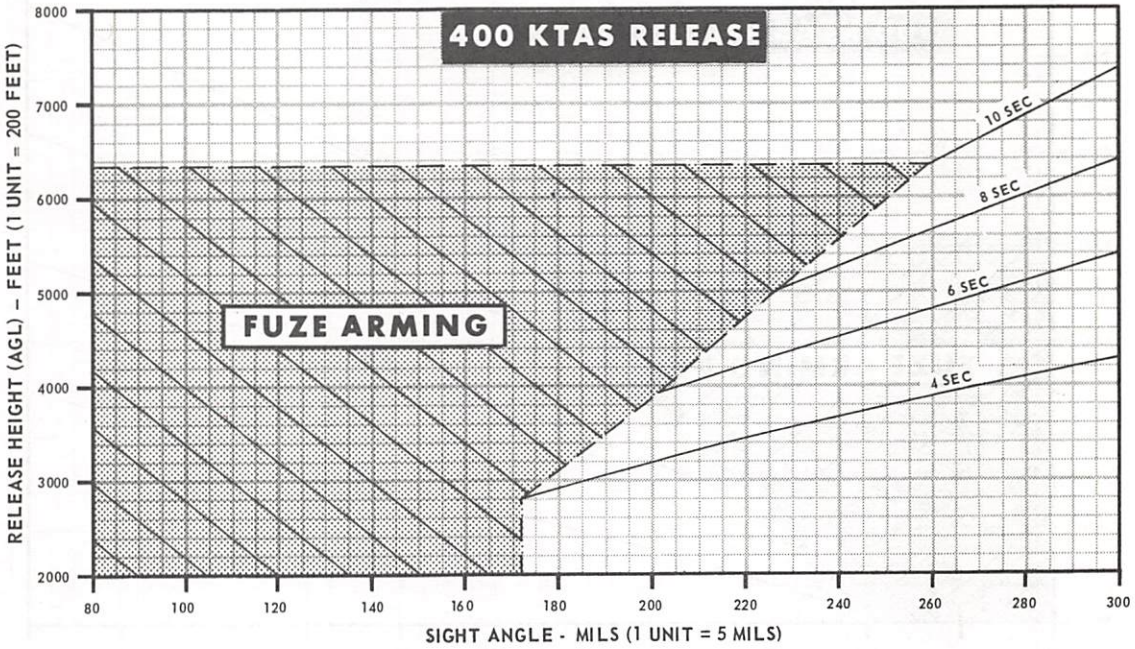
SIGHT ANGLE
CBU-24/B, -29/B-49/B DISPENSER
30° DIVE

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.



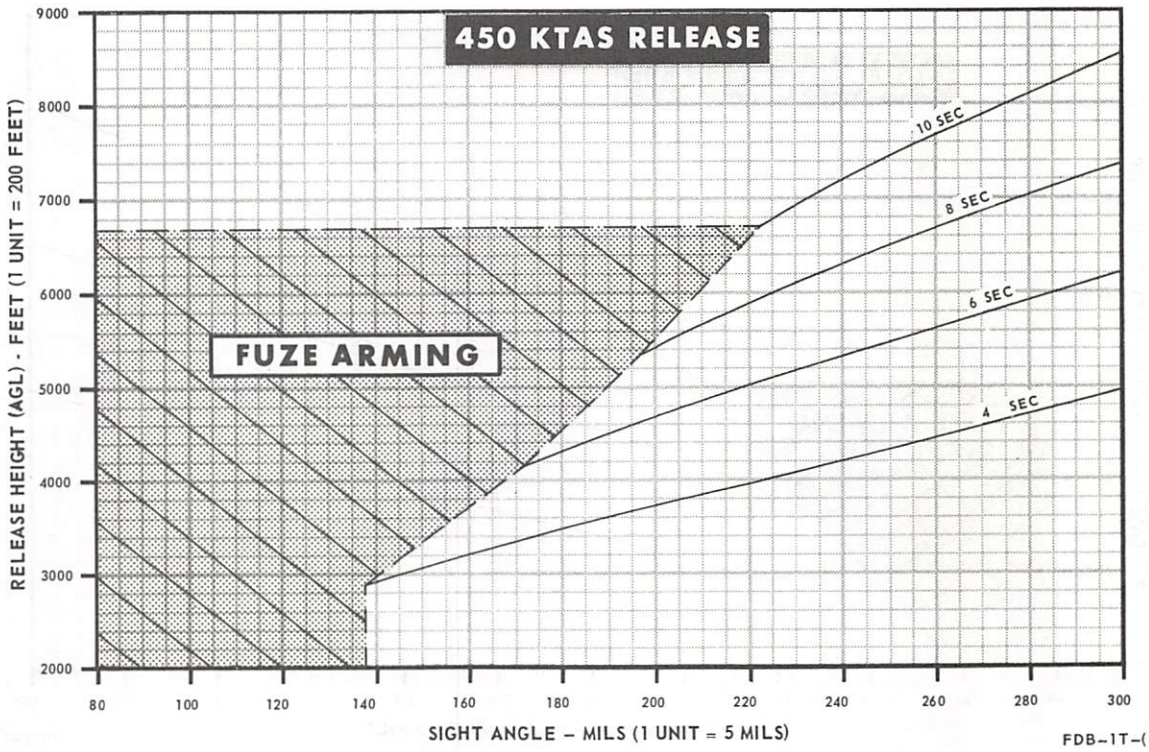


Figure 2-92 (U) (Sheet 7 of 22)

SIGHT ANGLE
CBU-24/B, -29/B -49/B DISPENSER
30° DIVE

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.

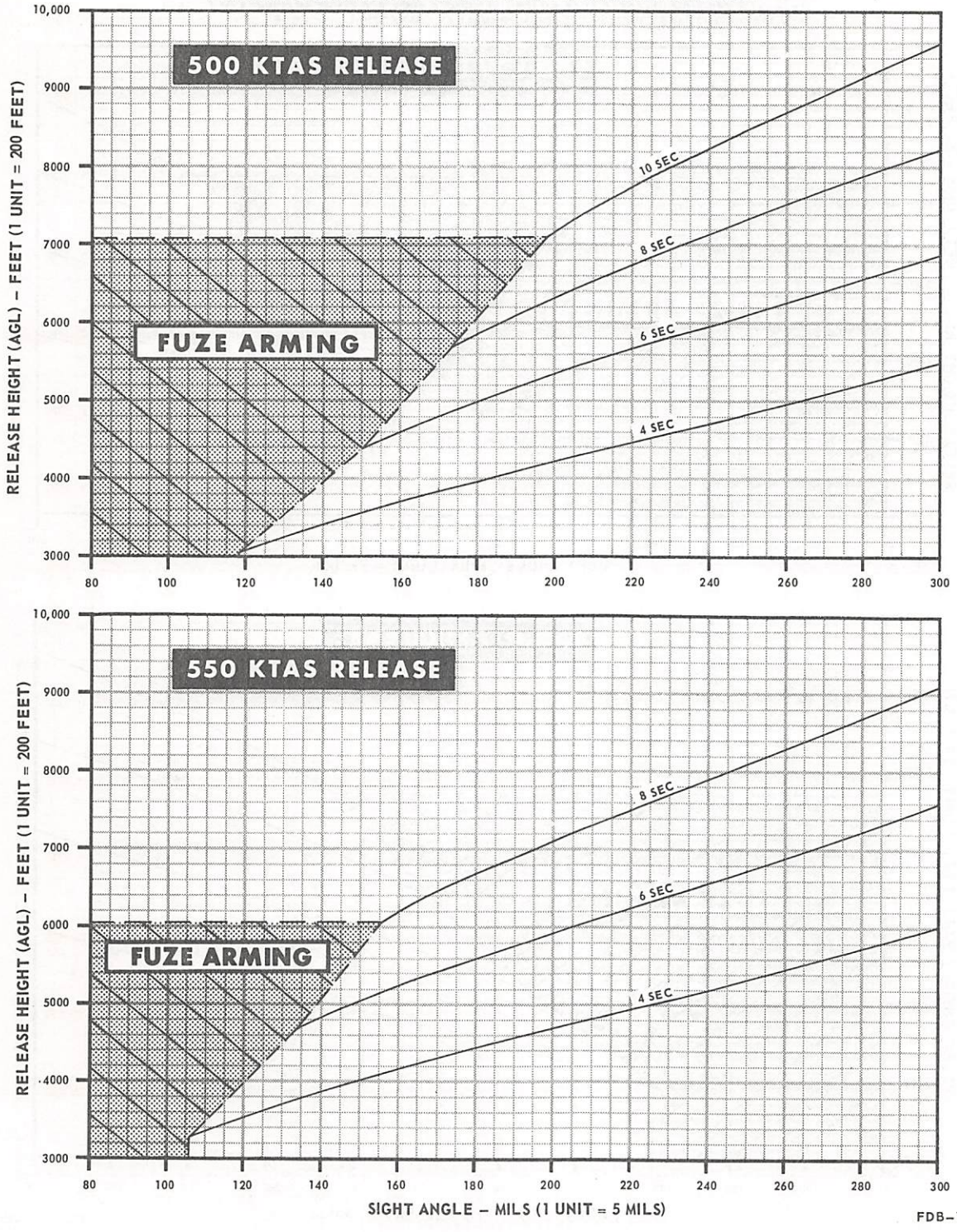


Figure 2-92 (U) (Sheet 8 of 22)

SIGHT ANGLE
CBU-24/B, -29/B -49/B DISPENSER
45° DIVE

NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.

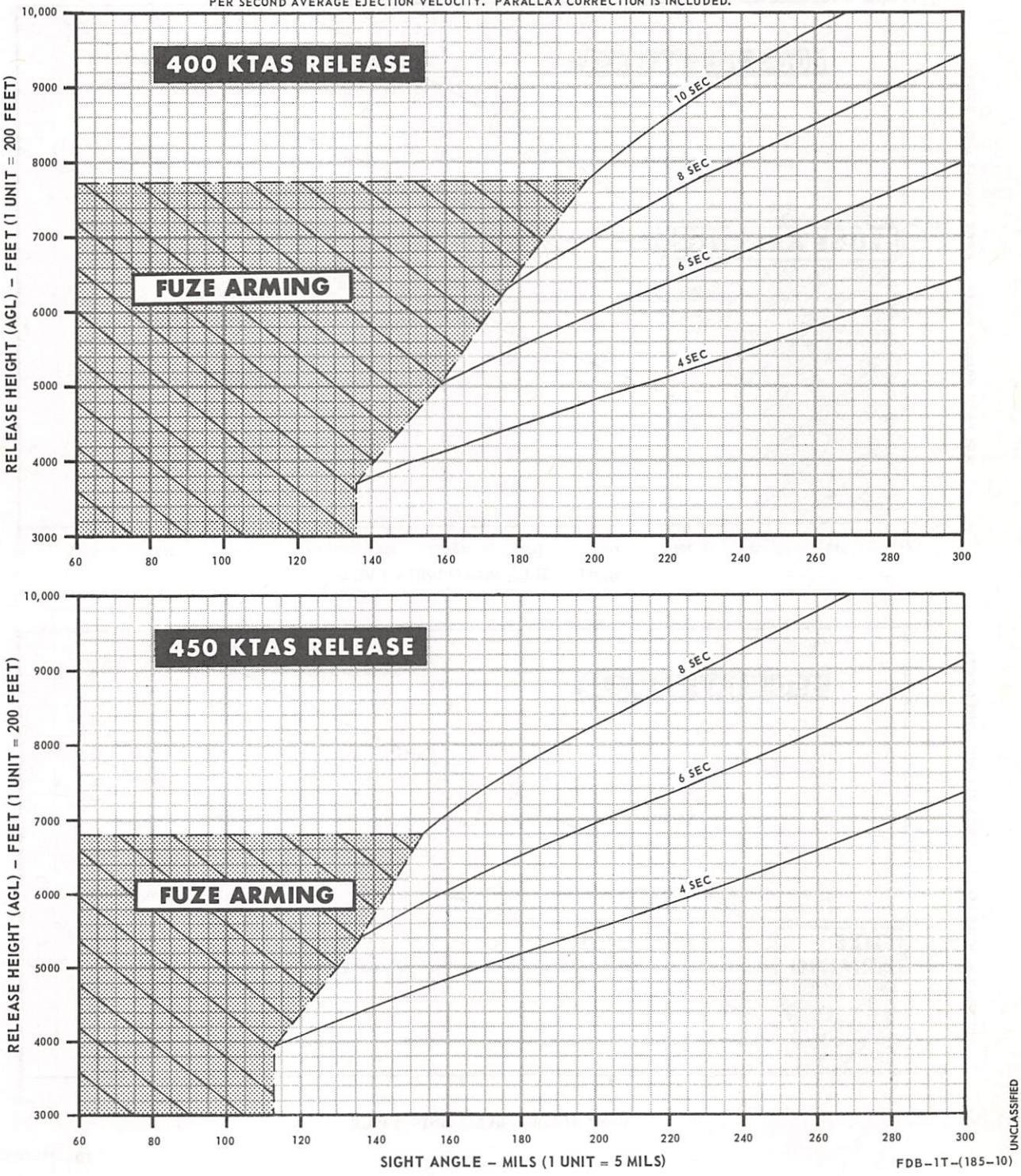


Figure 2-92 (U) (Sheet 9 of 22)

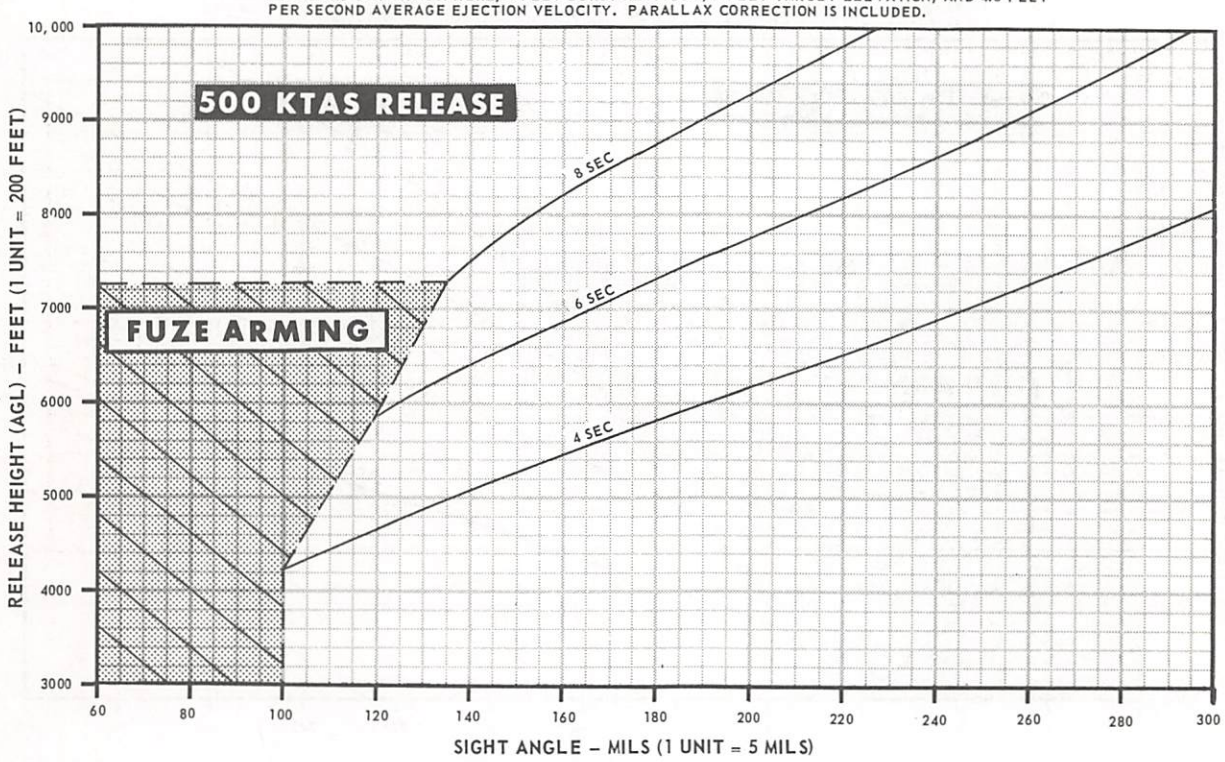
SIGHT ANGLE
CBU-24/B, -29/B -49/B DISPENSER
45° DIVE

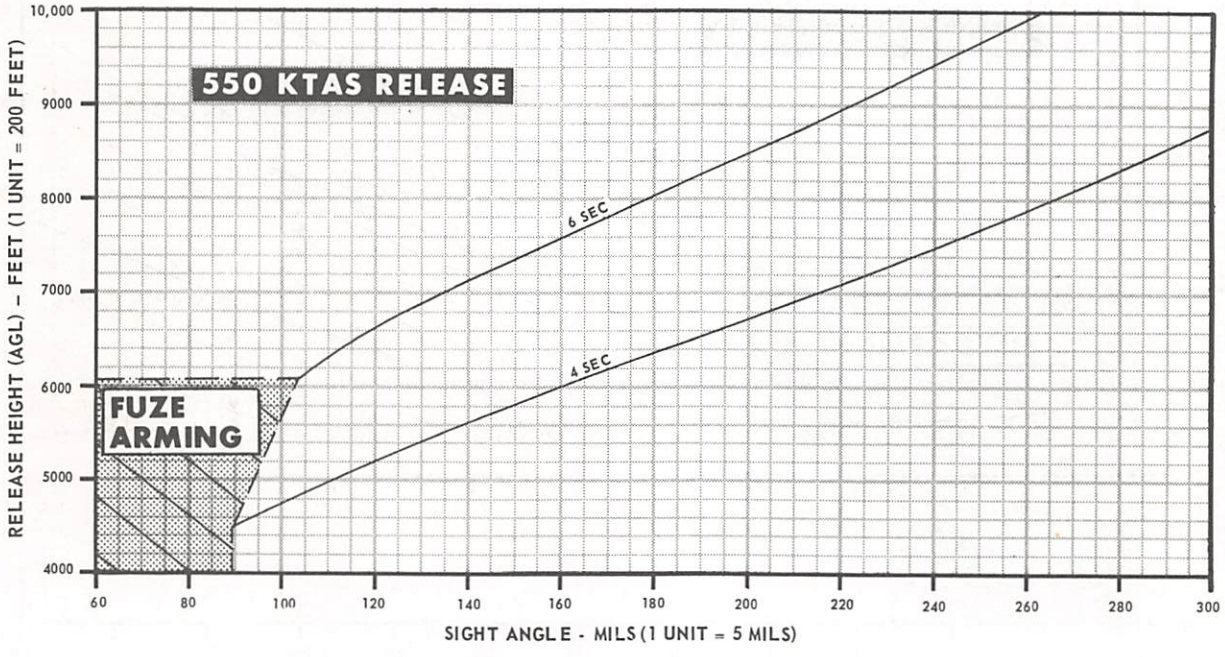
NOTE

SIGHT ANGLE WILL PLACE THE CENTER OF THE PATTERN DIAMETER OF ONE DISPENSER ON TARGET.

THE RELEASE RESTRICTED DUE TO ARMING LIMITATION IS BASED ON THE ARMING TOLERANCE OF THE M907 FUZE AND THE ARMING TIME REQUIRED BY THE BLU-26/B AND BLU-36/B FUZES.

SIGHT ANGLES ARE BASED ON 42,000 POUND AIRCRAFT GROSS WEIGHT, SINGLE DISPENSER RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 4.8 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.





UNCLASSIFIED

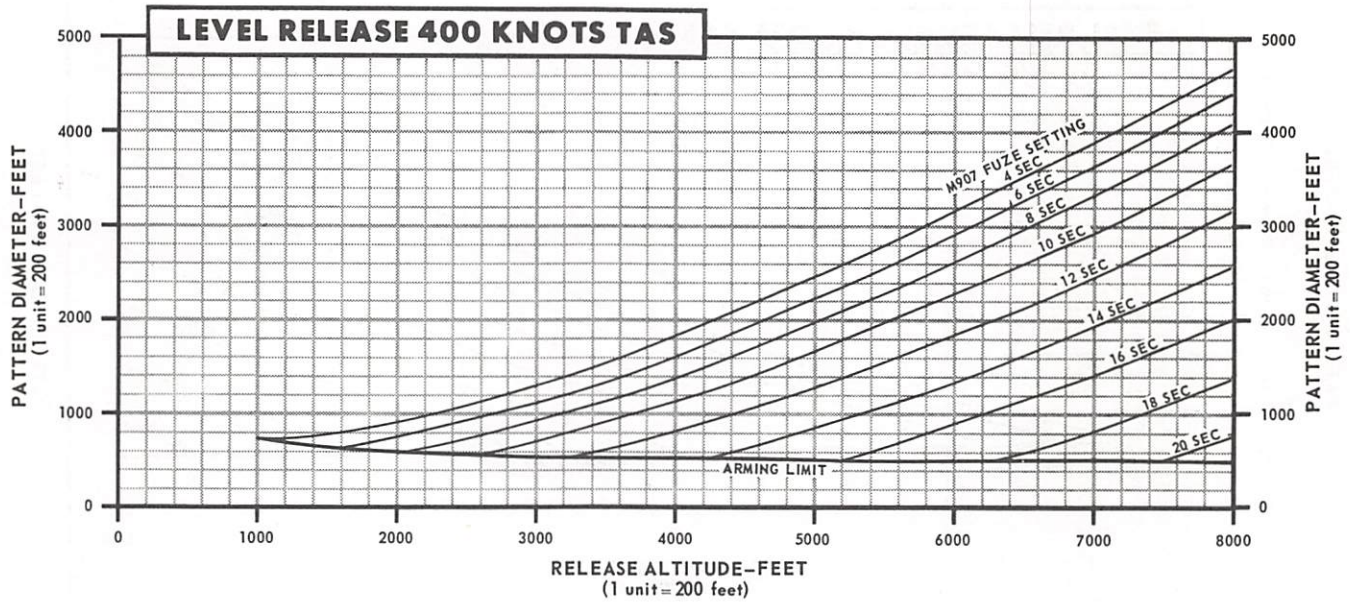
FDB-1T-(185-11)

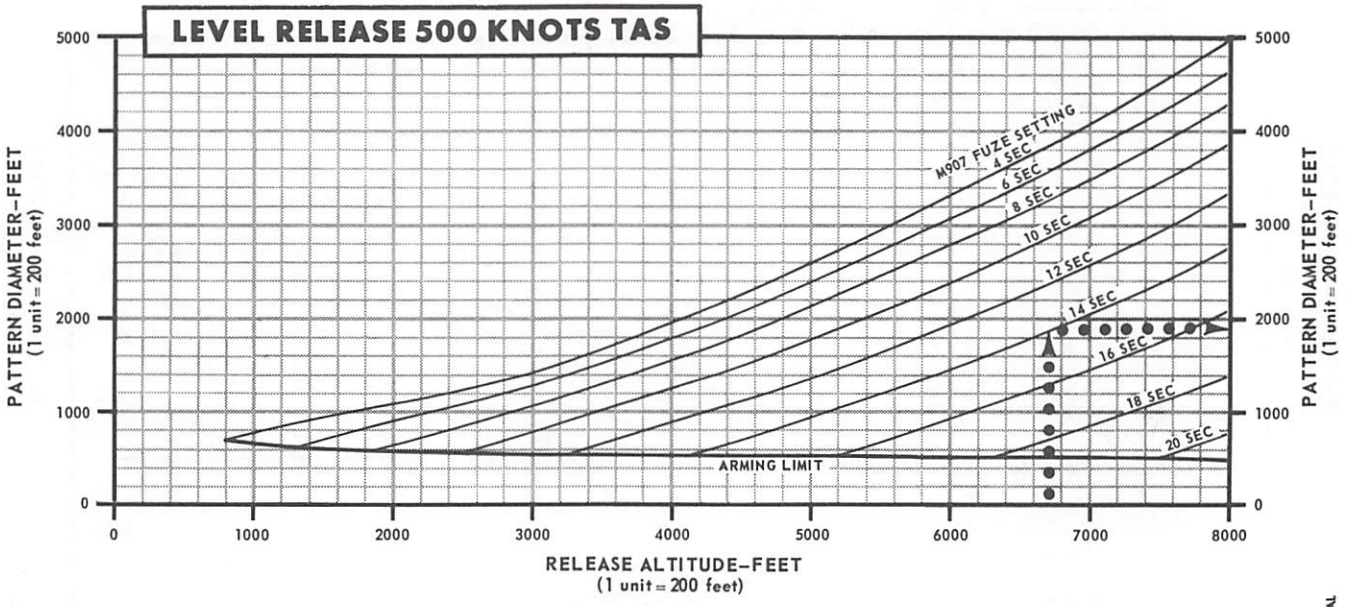
Figure 2-92 (U) (Sheet 10 of 22)

CBU-24, -29, -49 PATTERN AND ARMING

NOTE

(C) (GP-4) AN IMPACT PATTERN OF 700 TO 900 FEET DIAMETER IS OPTIMUM.





CONFIDENTIAL

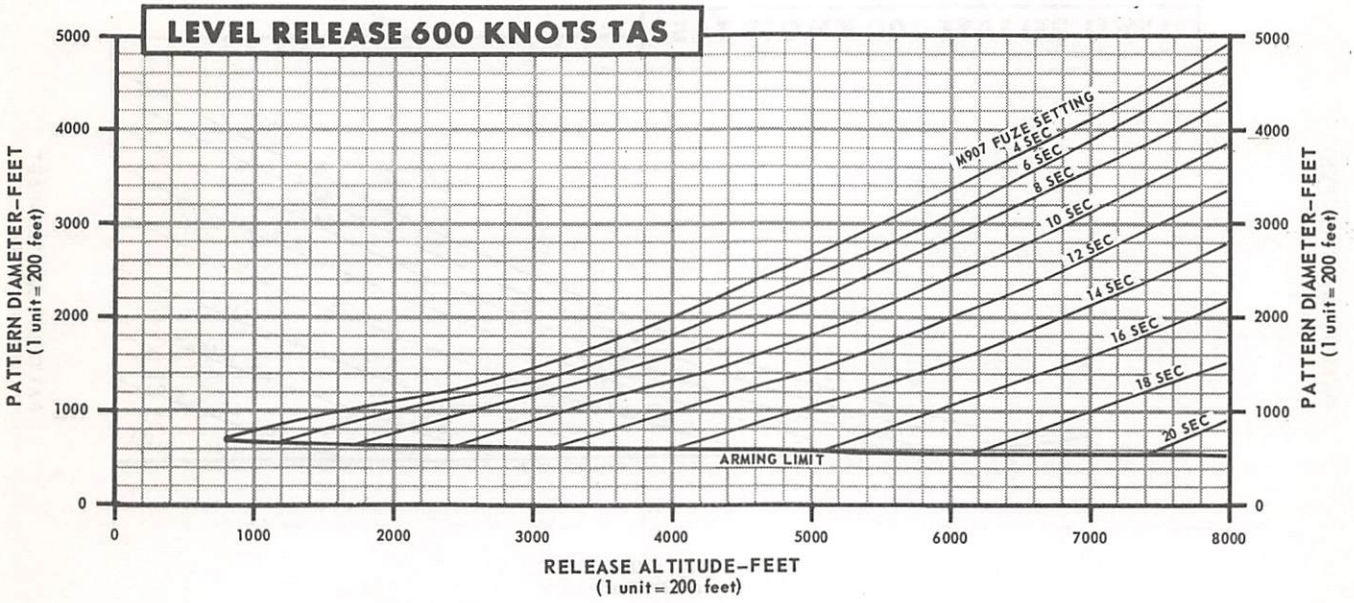
FDB–1T–(185–12)

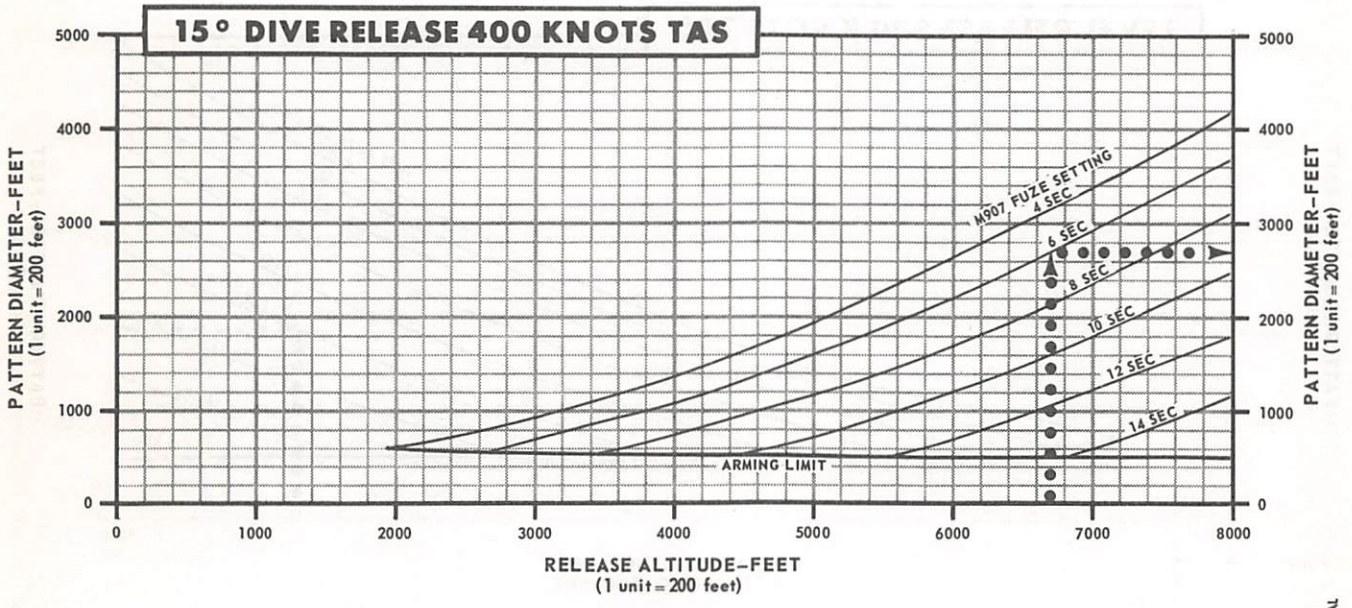
Figure 2-92 (U) (Sheet 11 of 22)

CBU-24, -29, -49 PATTERN AND ARMING

NOTE

(C) (GP-4) AN IMPACT PATTERN OF 700 TO 900 FEET DIAMETER IS OPTIMUM.





CONFIDENTIAL

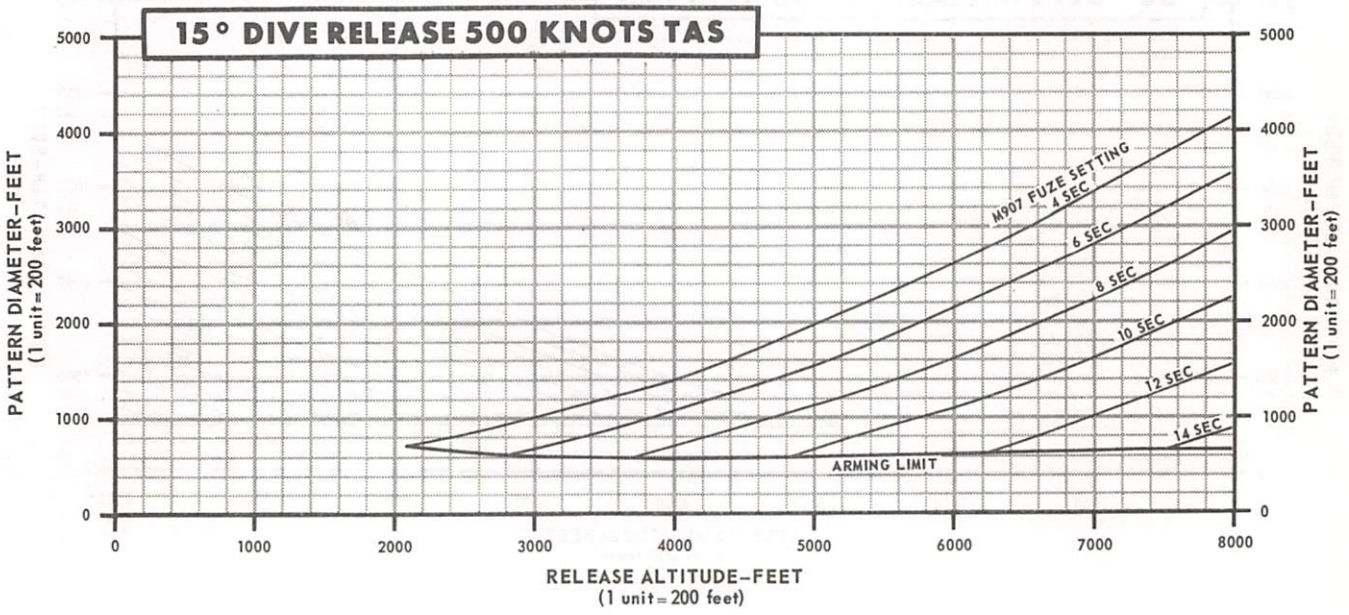
FDB–1T–(185–13)

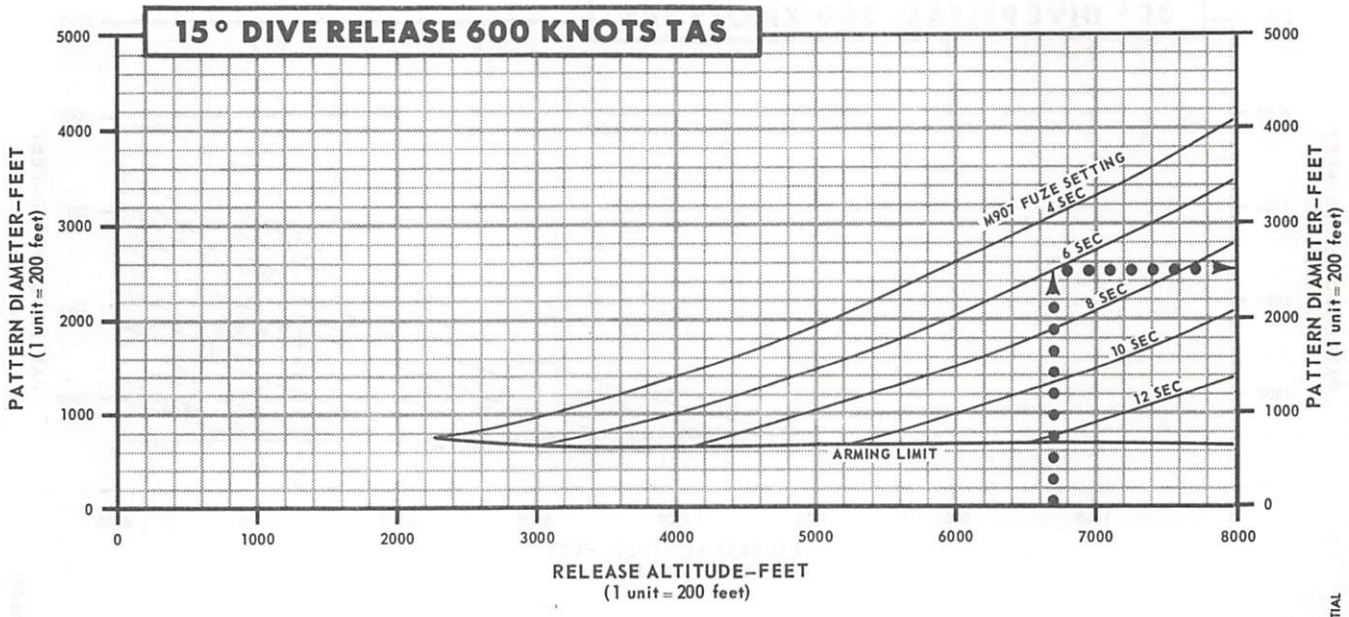
Figure 2-92 (C) (Sheet 12 of 22)

CBU-24, -29, -49 PATTERN AND ARMING

NOTE

(C) (GP-4) AN IMPACT PATTERN OF 700 TO 900 FEET DIAMETER IS OPTIMUM





CONFIDENTIAL

FDB–1T–(185–14)

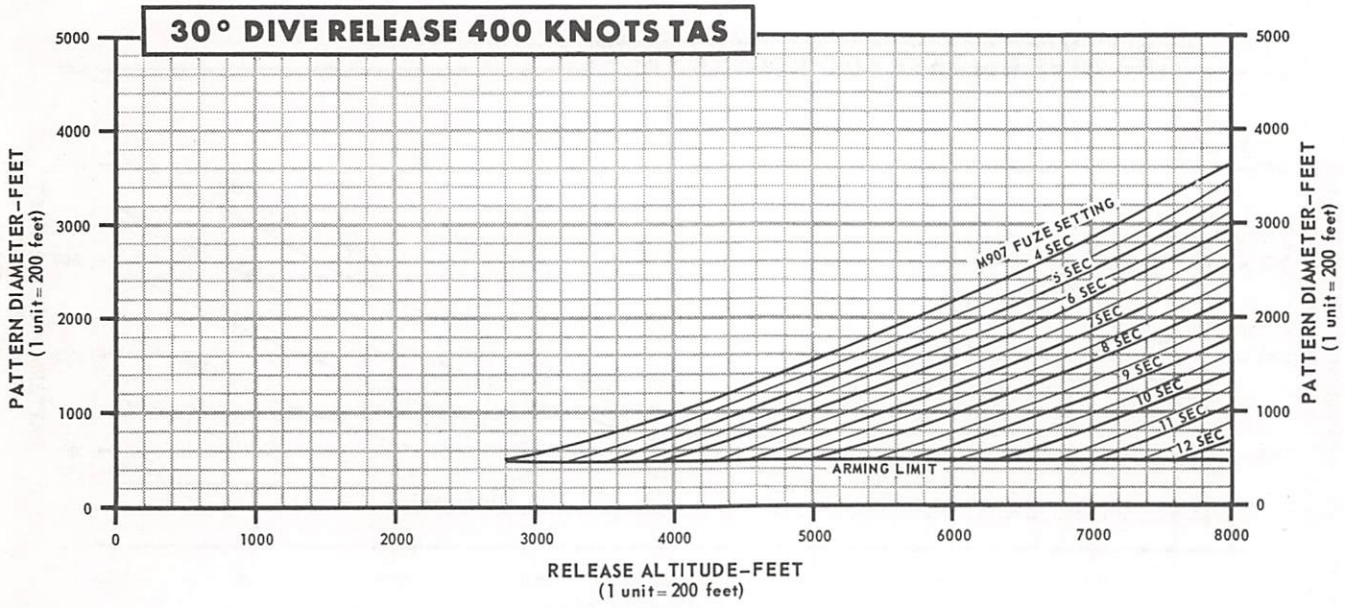
Figure 2-92 (C) (Sheet 13 of 22)

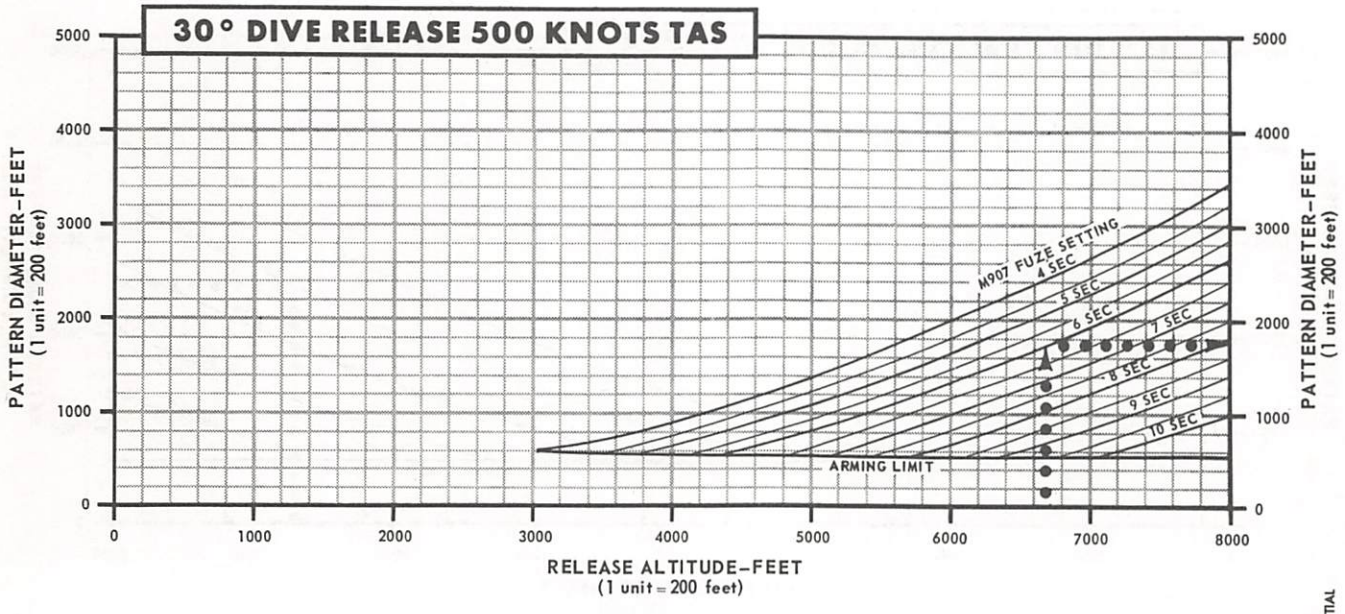
[redacted]

CBU-24, -29, -49 PATTERN AND ARMING

NOTE

(C) (GP-4) AN IMPACT PATTERN OF 700 TO 900 FEET DIAMETER IS OPTIMUM.





CONFIDENTIAL

FDB–1T–(185–15)

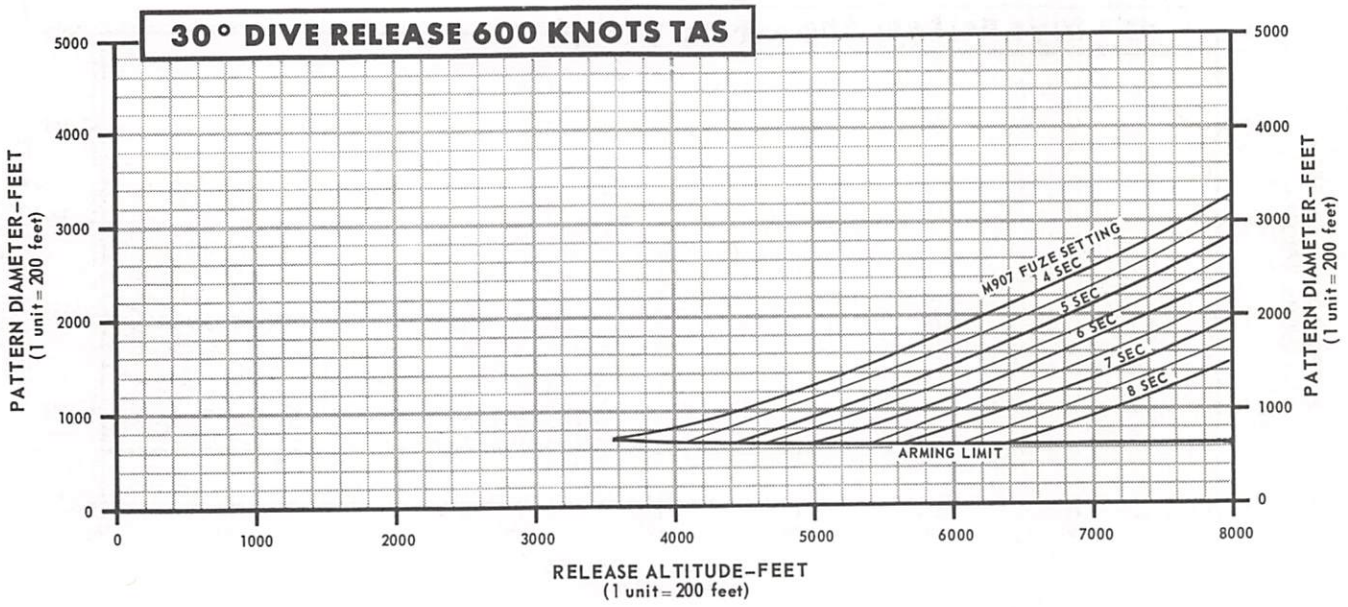
Figure 2-92 (C) (Sheet 14 of 22)

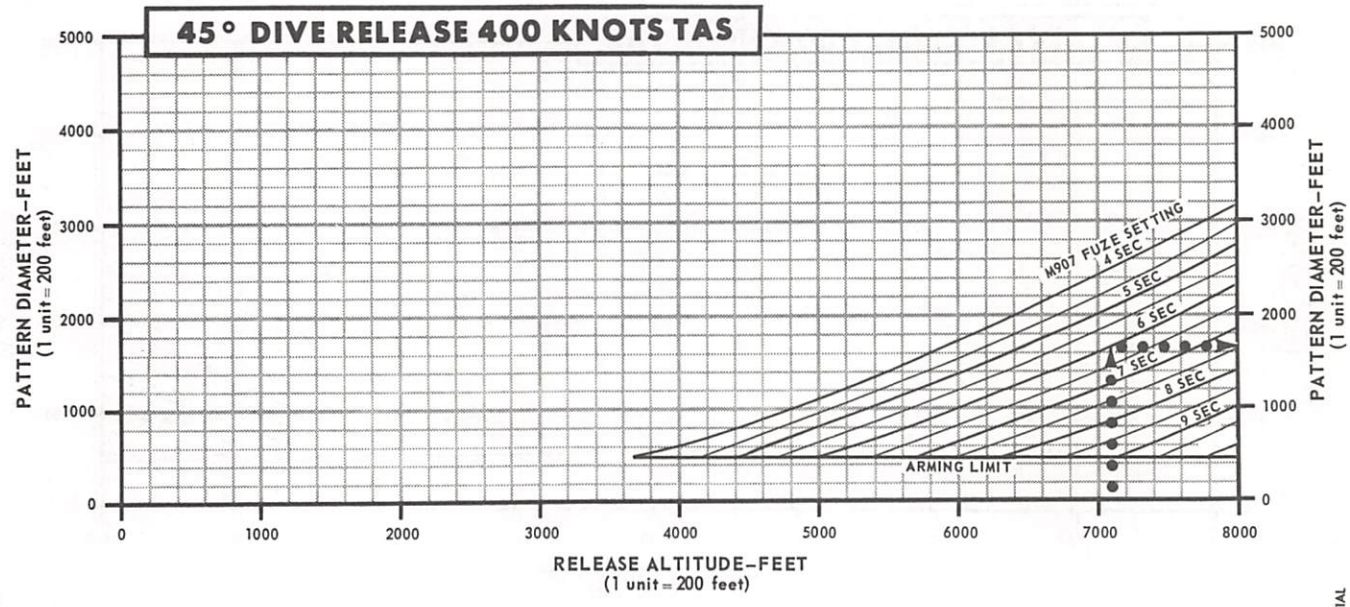
[redacted]

CBU-24, -29, -49 PATTERN AND ARMING

NOTE

(C) (GP-4) AN IMPACT PATTERN OF 700 TO 900 FEET DIAMETER IS OPTIMUM.





CONFIDENTIAL

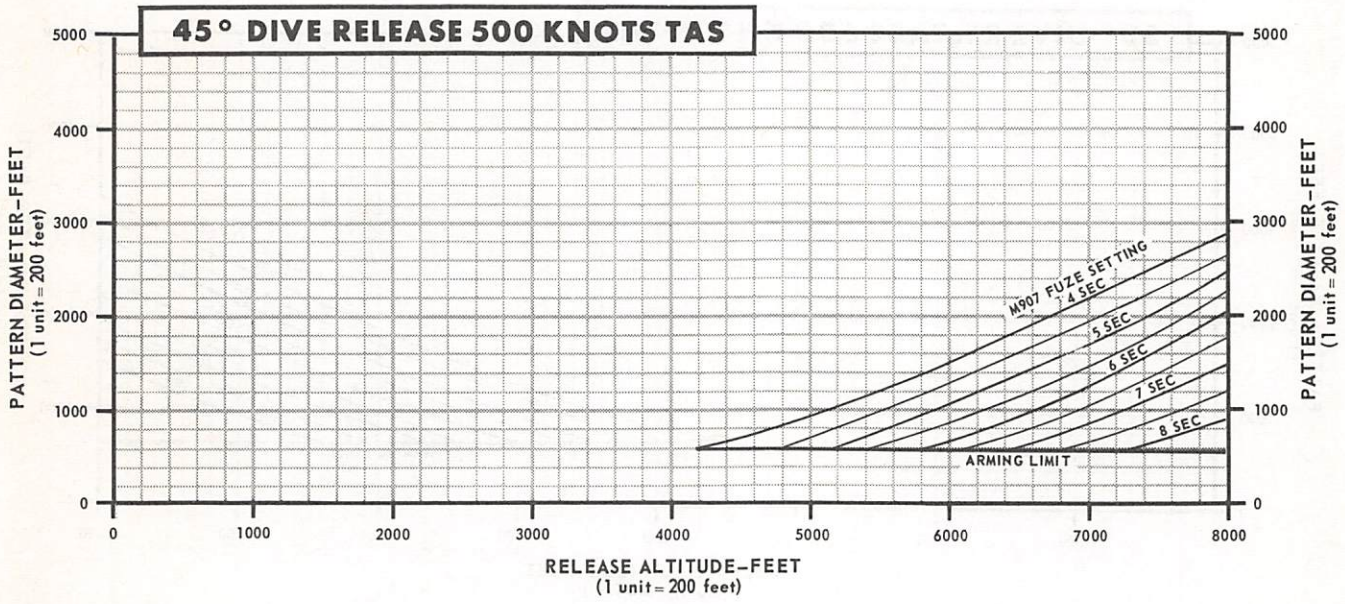
FDB–1T–(185–16)

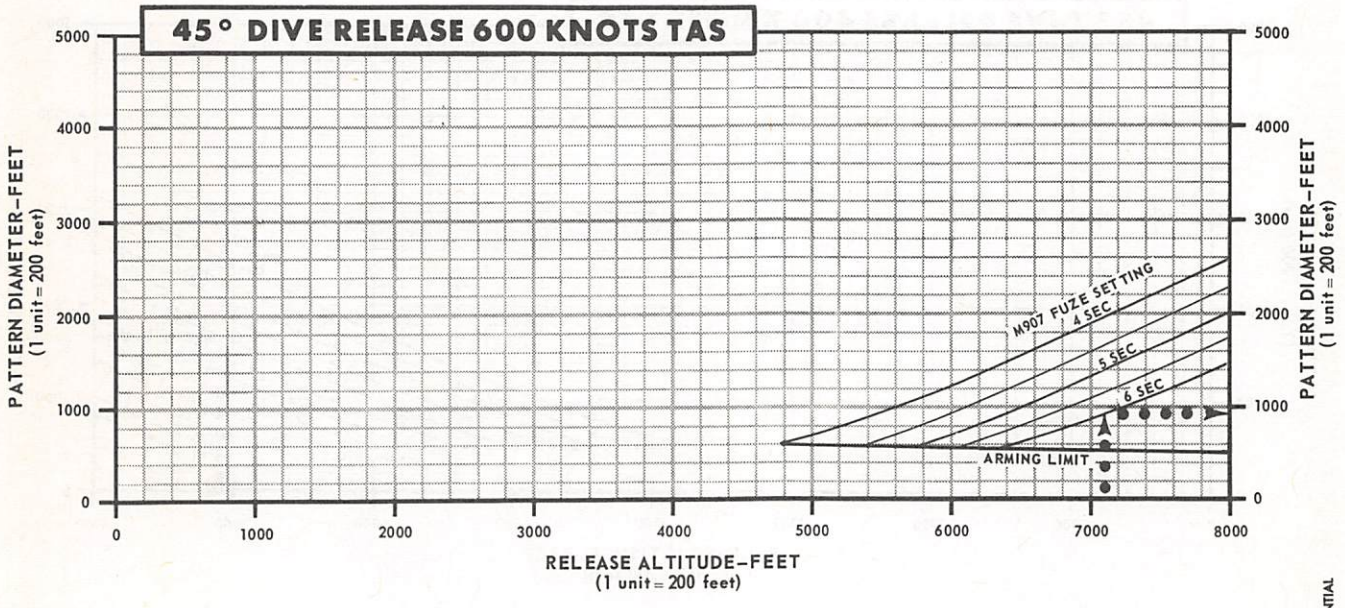
Figure 2-92 (C) (Sheet 15 of 22)

CBU-24, -29, -49 PATTERN AND ARMING

NOTE

(C) (GP-4) AN IMPACT PATTERN OF 700 TO 900 FEET DIAMETER IS OPTIMUM.





CONFIDENTIAL

FDB-1T-(185-17)

Figure 2-92 (C) (Sheet 16 of 22)

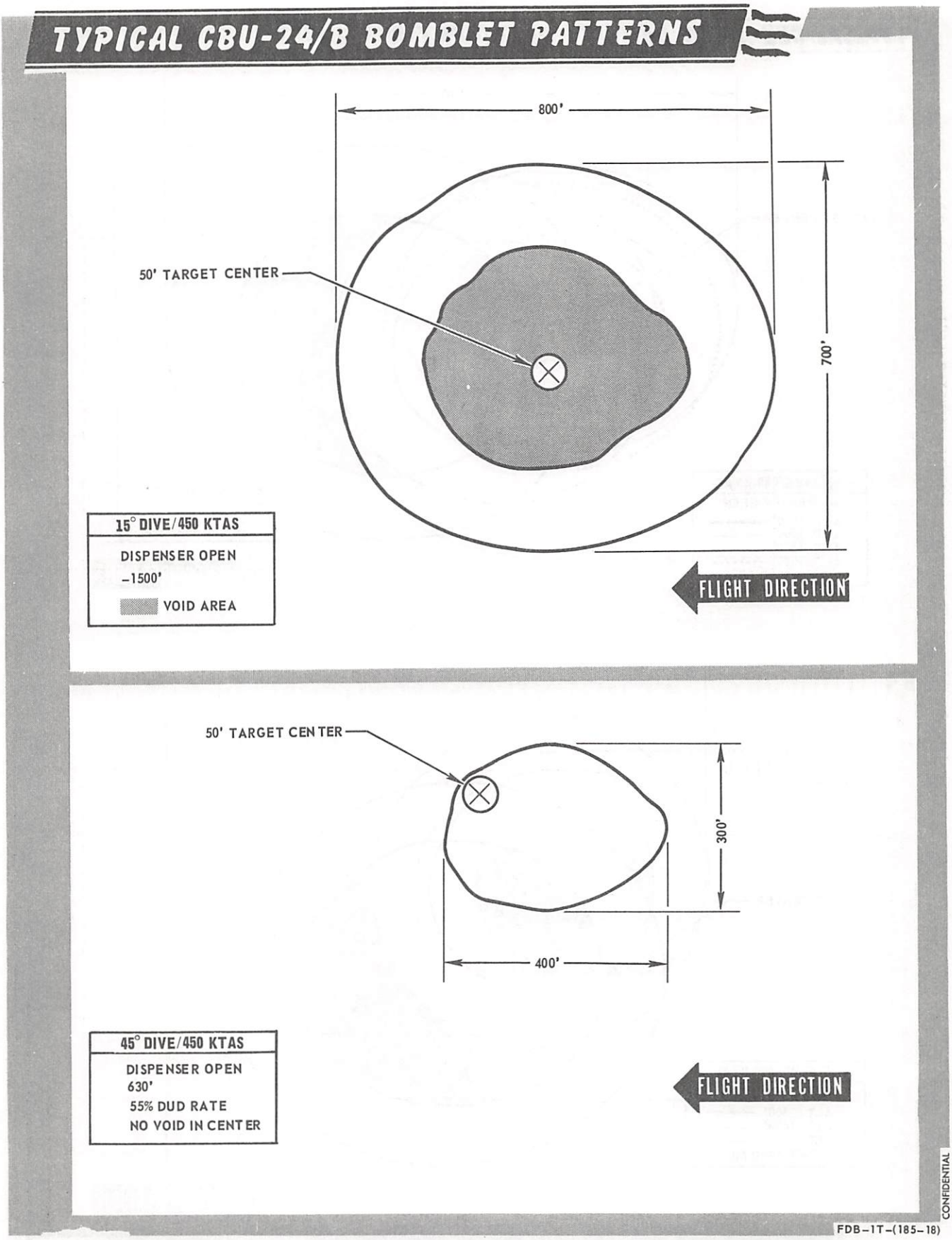


Figure 2-92 (C) (Sheet 17 of 22)

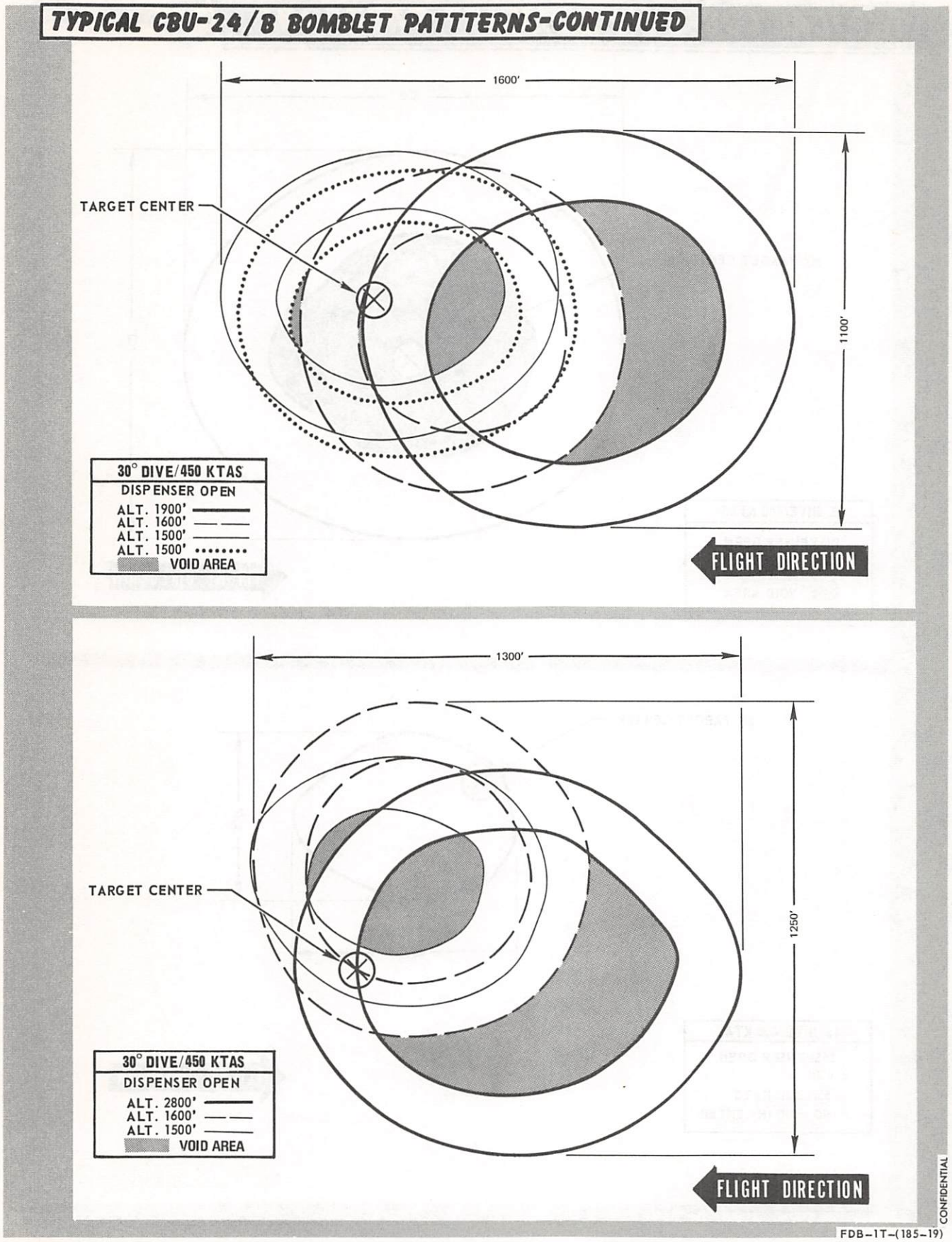


Figure 2-92 (C) (Sheet 18 of 22)

TYPICAL CBU-24/B BOMBLET PATTERNS- CONTINUED

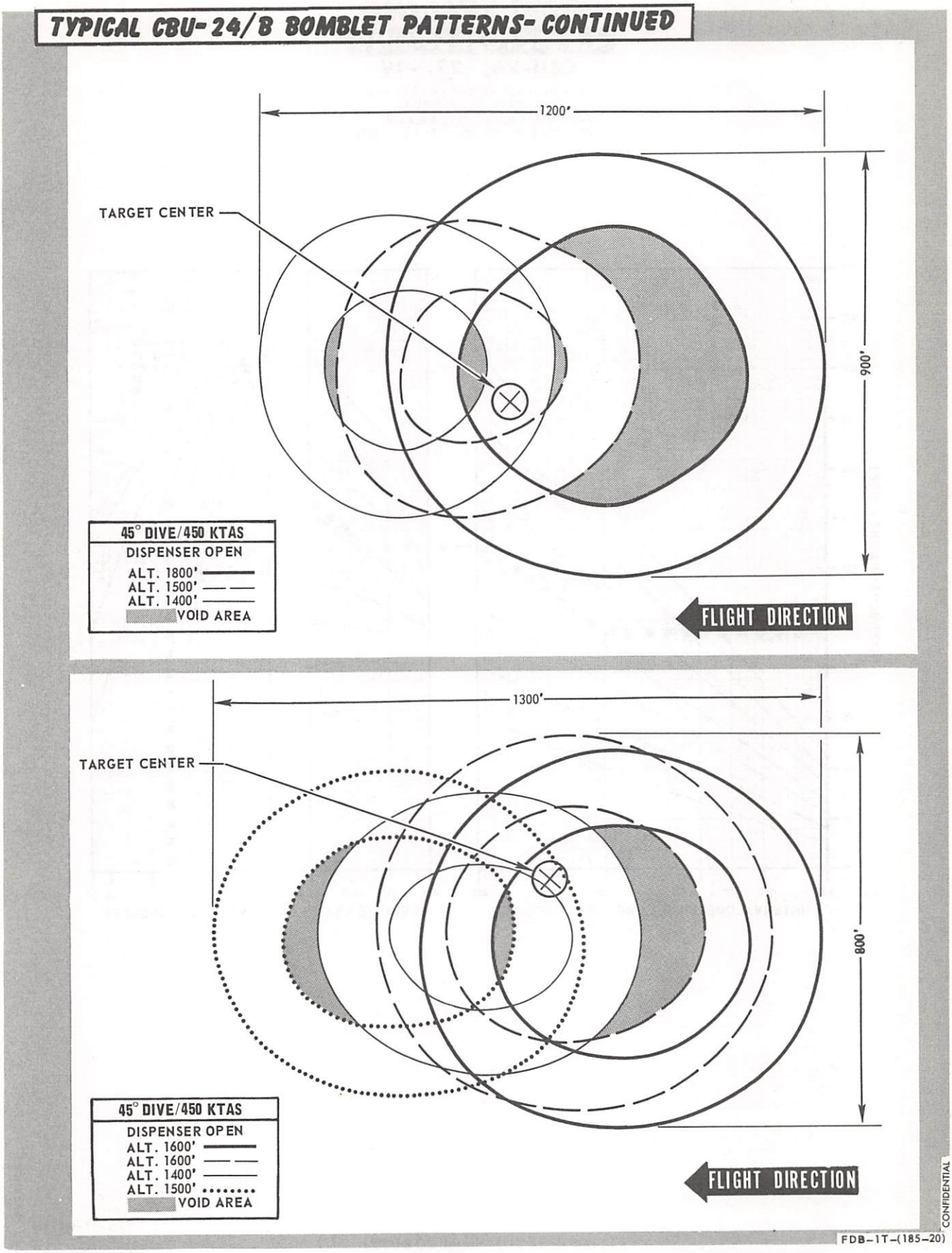


Figure 2-92 (C) (Sheet 19 of 22)

[redacted]

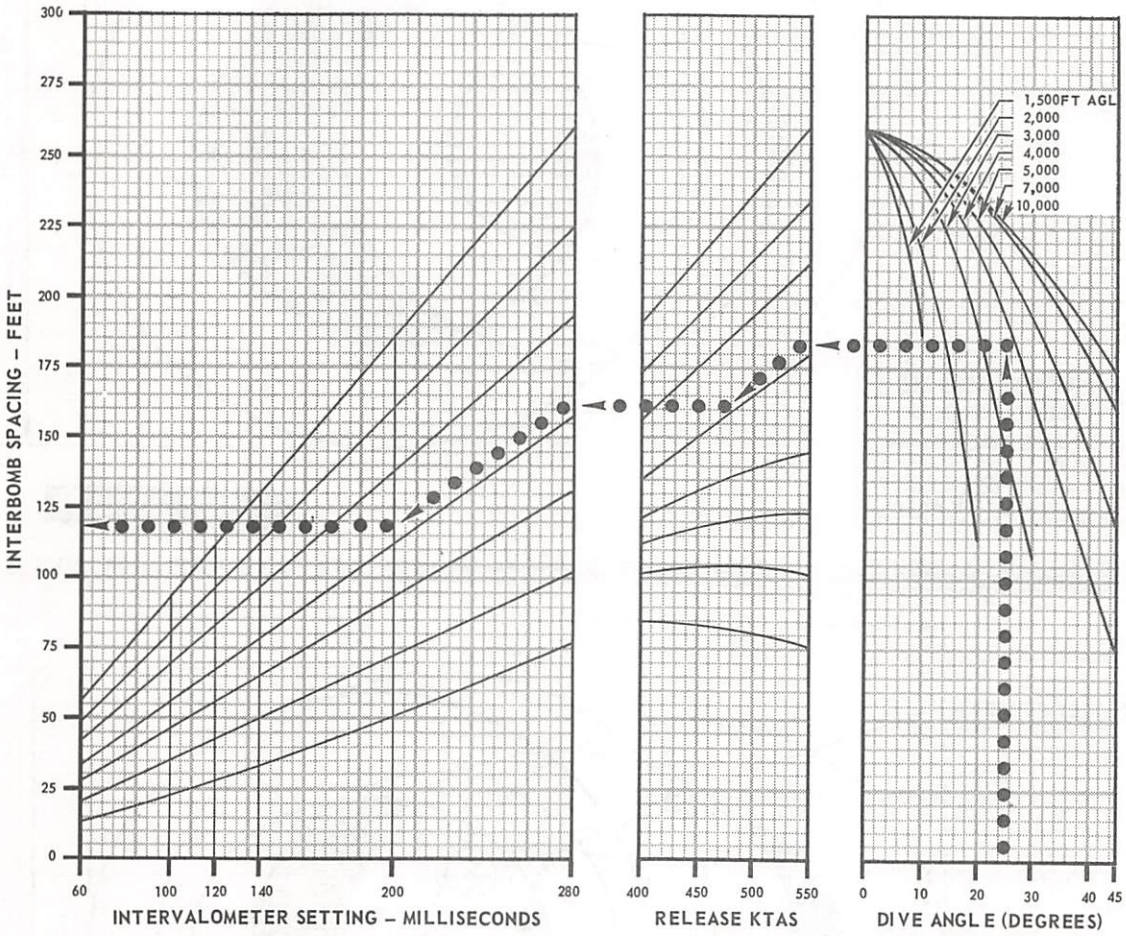
BOMB SPACING

4.0 SEC FUZE SETTING

CBU-24, -29, -49

USE RELEASE HEIGHT AND RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE, MER-TER EJECTION VELOCITY 4.8 FT/SEC)



UNCLASSIFIED

FDB-1T-(185-21)

Figure 2-92 (U) (Sheet 20 of 22)

[redacted]

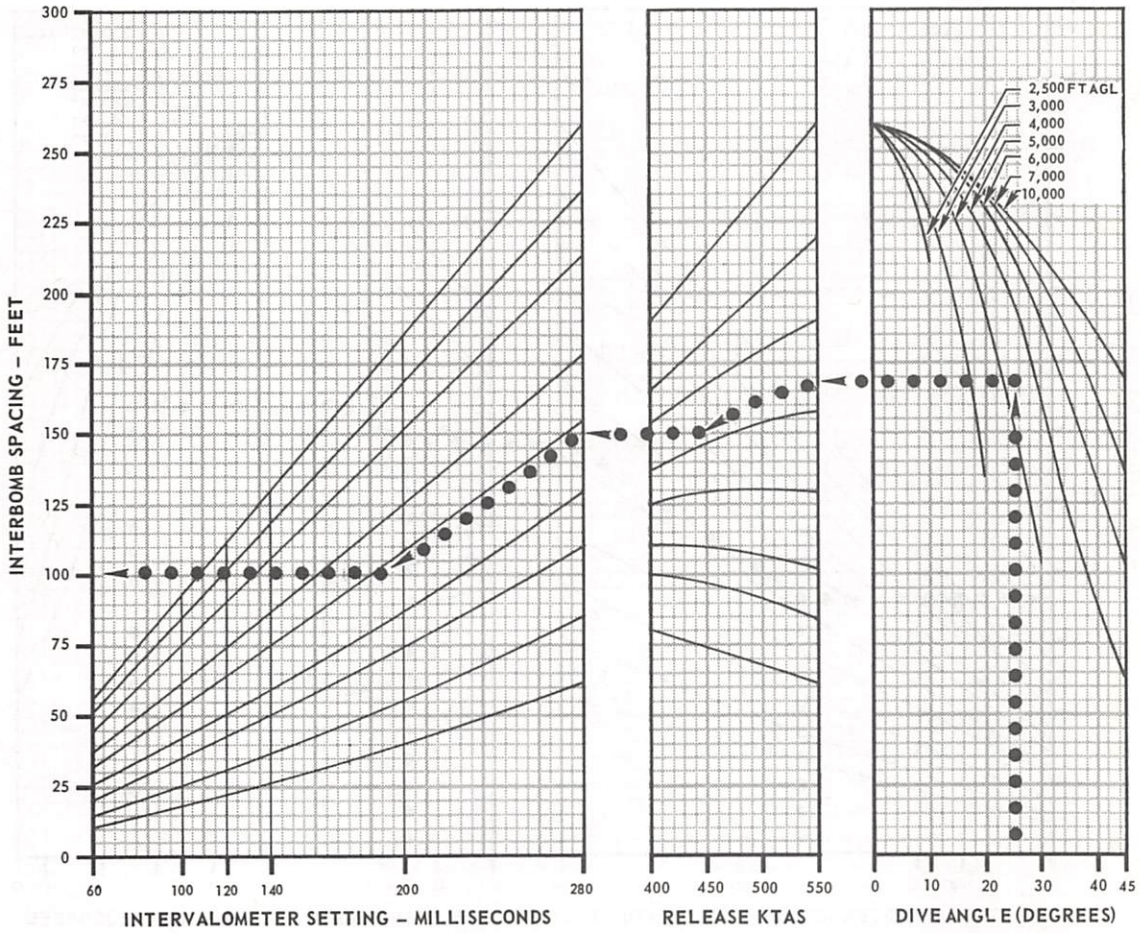
BOMB SPACING

6.0 SEC FUZE SETTING

CBU-24, -29, -49

USE RELEASE HEIGHT AND RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE, MER-TER EJECTION VELOCITY 4.8 FT/SEC)



FDB-1T-(185-22) UNCLASSIFIED

Figure 2-92 (U) (Sheet 21 of 22)

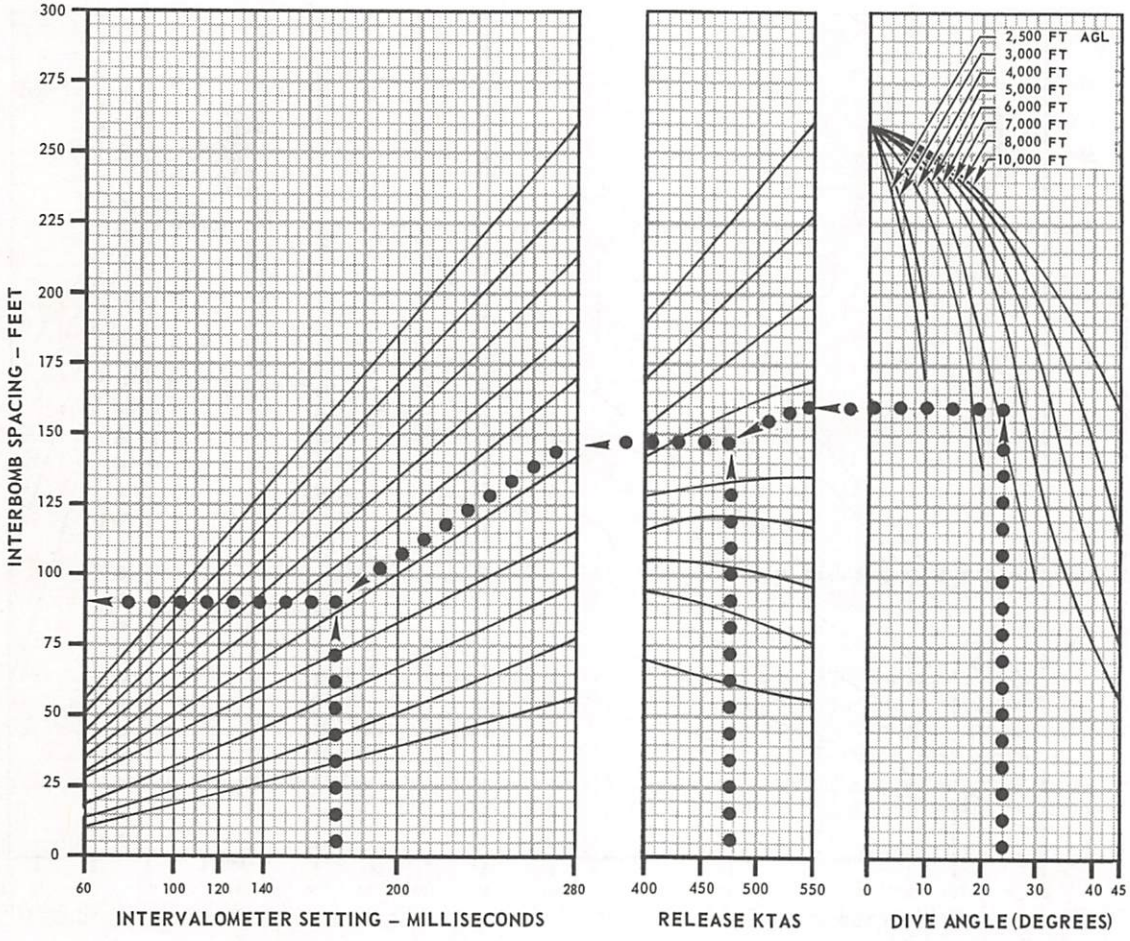
BOMB SPACING

8.0 SEC FUZE SETTING

CBU-24, -29, -49

USE RELEASE HEIGHT AND RELEASE AIRSPEED OF LAST BOMB

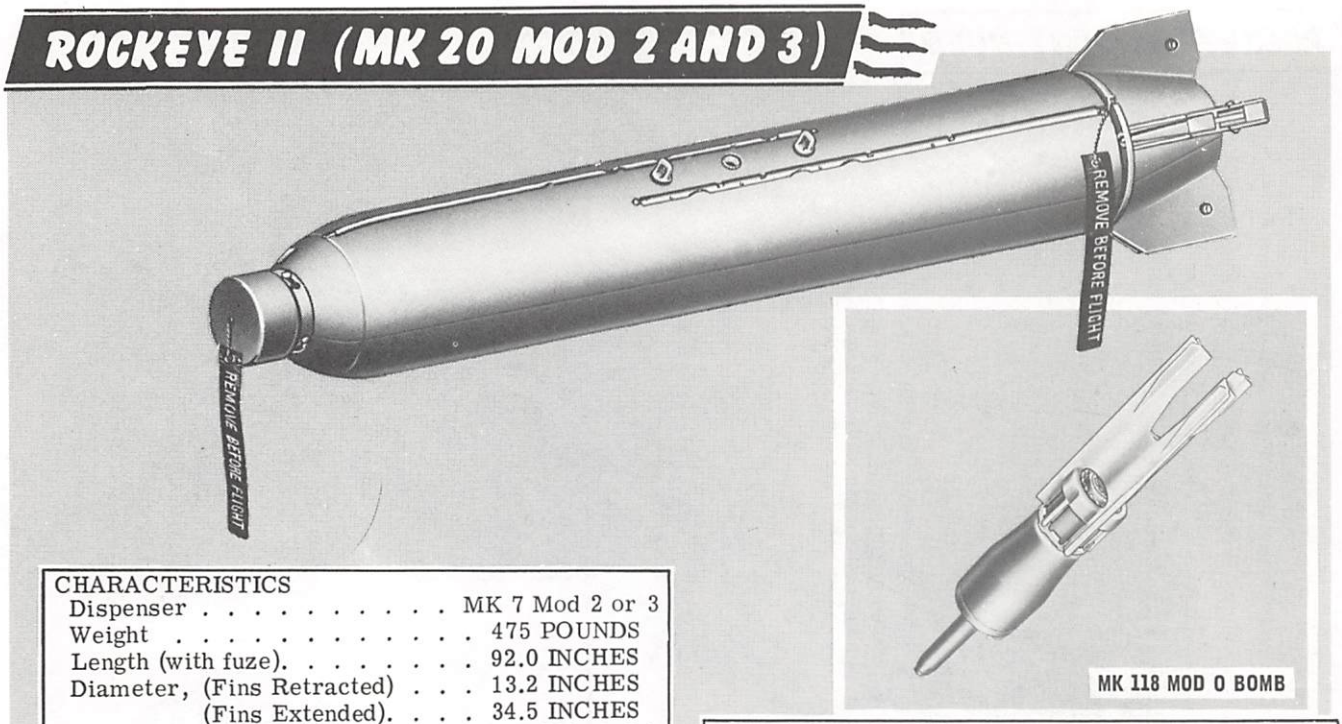
(BASED ON SIX BOMB RIPPLE RELEASE, MER-TER EJECTION VELOCITY 4.8 FT/SEC)



FDB-1T-(185-23) UNCLASSIFIED

Figure 2-92 (U) (Sheet 22 of 22)

ROCKEYE II (MK 20 MOD 2 AND 3)



CHARACTERISTICS	
Dispenser	MK 7 Mod 2 or 3
Weight	475 POUNDS
Length (with fuze)	92.0 INCHES
Diameter, (Fins Retracted)	13.2 INCHES
(Fins Extended)	34.5 INCHES
Fuze	MK 339 Mod 0
Bomblet Type	MK 118 Mod 0
Bomblet Capacity	247

MK 118 MOD 0 BOMB

CHARACTERISTICS	
Bomblet	MK 118 Mod 0
Diameter	2.1 INCHES
Length	13.5 INCHES
Weight	1.32 POUNDS
Weight of Explosive	0.39 POUND

DESCRIPTION

ROCKEYE II (Antitank Bomb Cluster, MK 20 Mod 2 and Mod 3) consists of the MK 7 Mod 2 or Mod 3 Dispenser loaded with MK 118 Mod 0 bomblets and the MK 339 Mod 0 mechanical time fuze. It is delivered to the fleet as an "all up" round.

In ROCKEYE II Mod 2, the Mk 339 fuze is pre-set to 4.0 seconds at the factory (no pilot option); in ROCKEYE II Mod 3, the Mk 339 fuze is pre-set for 1.2 seconds in the primary mode and 4.0 seconds in the option or secondary mode. These times are pre-set at the factory. However, timer settings of other times from 1.2 seconds to 50 seconds are available for pre-flight selection both the Mod 2 and the Mod 3. With the Mod 3, the pilot can select the primary mode by positioning the arm nose tail switch to NOSE; the option or secondary mode is selected when the switch is positioned to NOSE & TAIL.

The stabilizing fins are retracted until the weapon is released. At release, two wires are withdrawn which (1) Extend the fins, and (2) starts the fuze timer. At expiration of fuze arming time, the fuze fires a linear shaped charge splitting the dispenser and releasing the MK 118 bomblets. The bomblets are then individually armed and detonate on impact.

The MK 118 bomblet utilizes the MK 1 Mod 0 Fuzing System. This system contains a small tail mounted arming vane which arms the bomblet in about 1.5 seconds after release from the dispenser. An airspeed of 200 KCAS or greater is required for reliable arming of the bomblet. A nose element in the fuze detonates the bomblet instantaneously and with a shaped charge effect on impact with hard targets (steel, concrete). The tail fuze detonates the bomblet after a very short delay on impact with softer targets. This discriminating feature of the fuze permits penetration of light material (vegetation, camouflage nets, light plywood) with detonation delayed until bomblet impacts a more solid surface beneath the superficial covering. A small observation window in the side of tail fuze shows RED if armed; GREEN if safe.

REFERENCES.

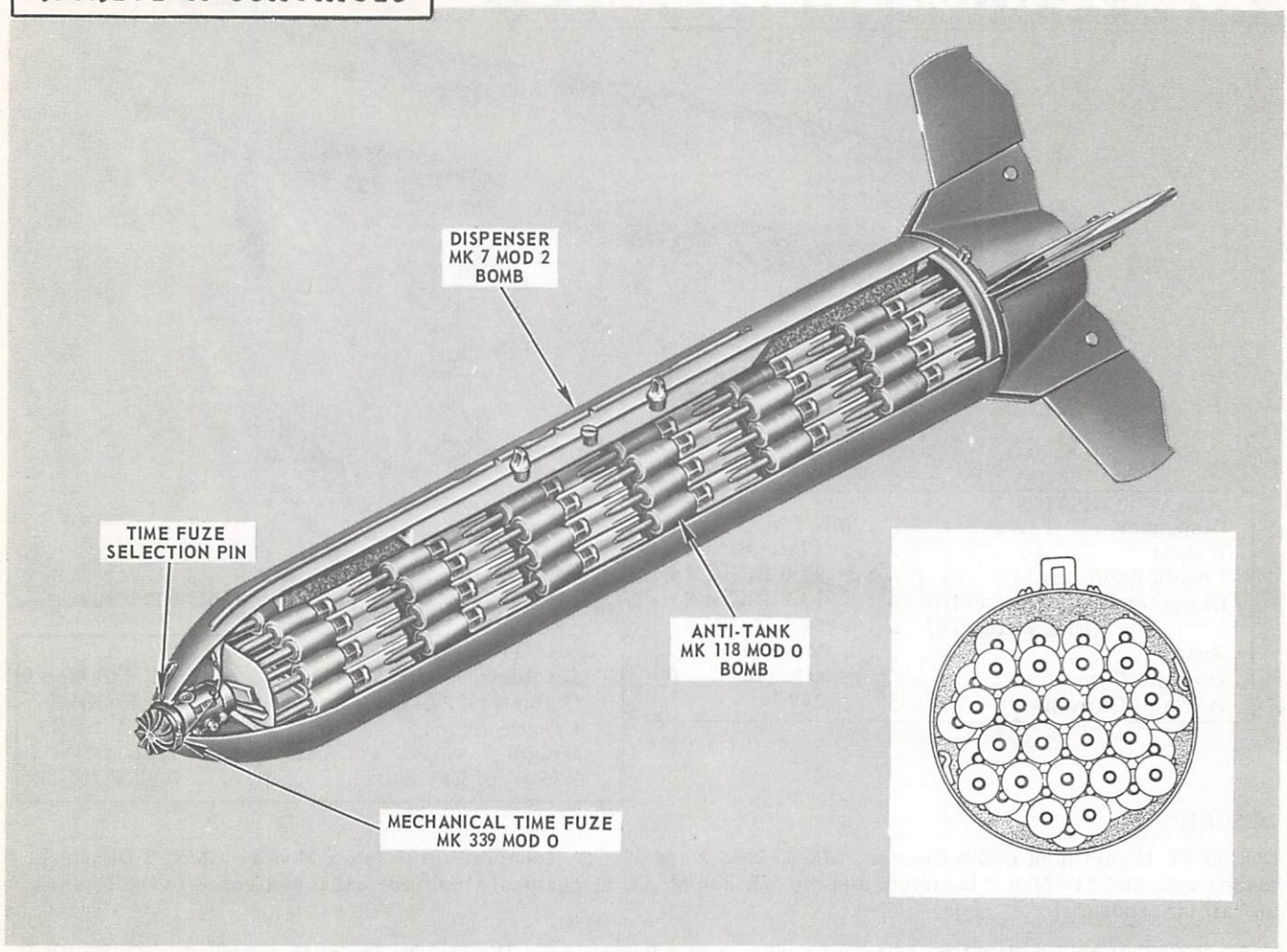
1. Loading . . . . . NAVAIR 01-245FDB-75
2. Fuzing and Fuze Limits. . . . . Section II, Part 1
3. External Store Limitations . . . . . Appendix A
4. Weapon Assembly . . . . . NAVAIR 11-5A-3
5. Current AAB's
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-14.3

CONFIDENTIAL

FDB-1T-(186-1)

Figure 2-93 (C) (Sheet 1 of 20

ROCKEYE II-CONTINUED



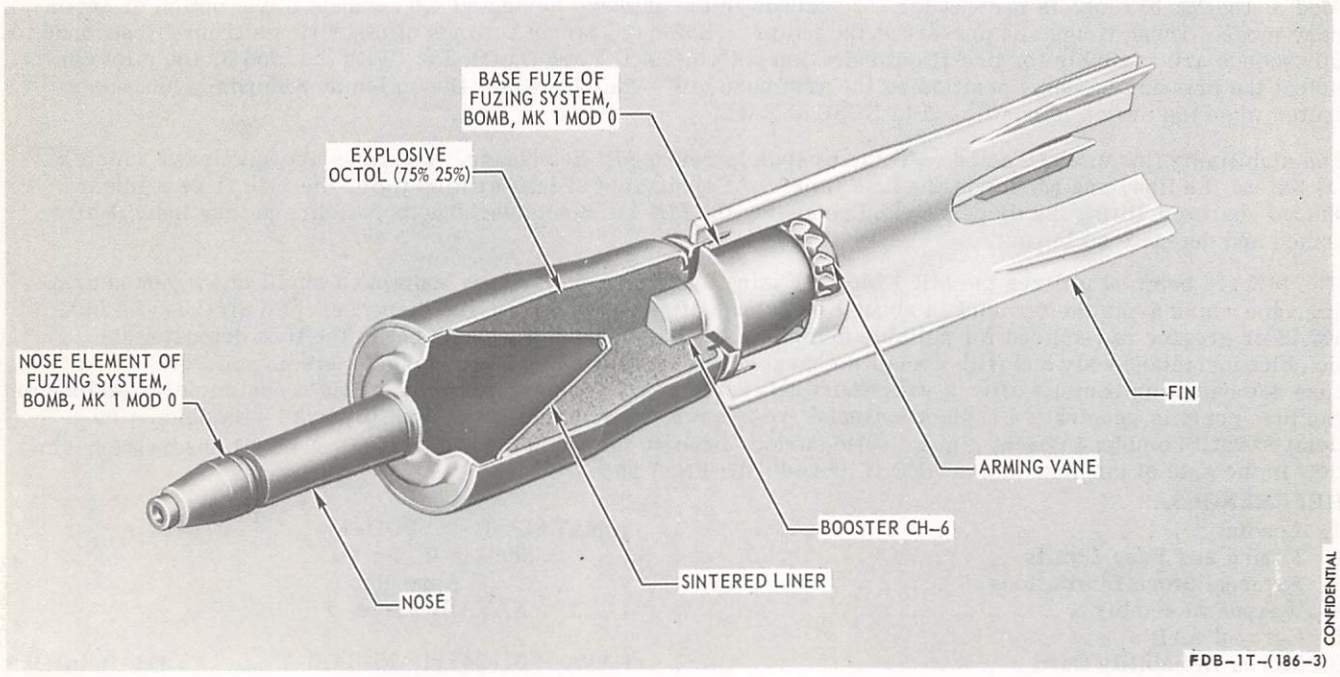
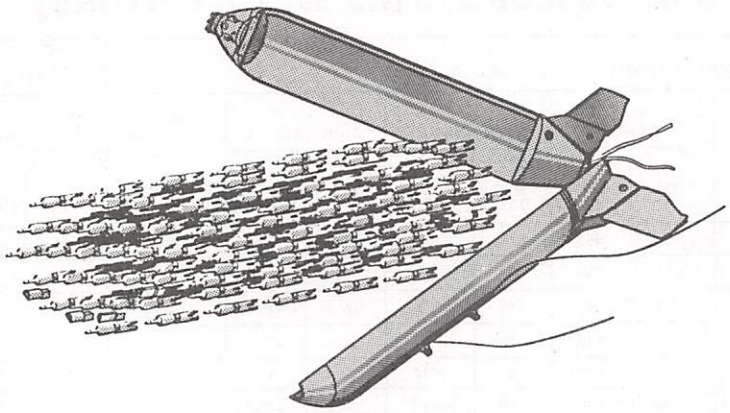
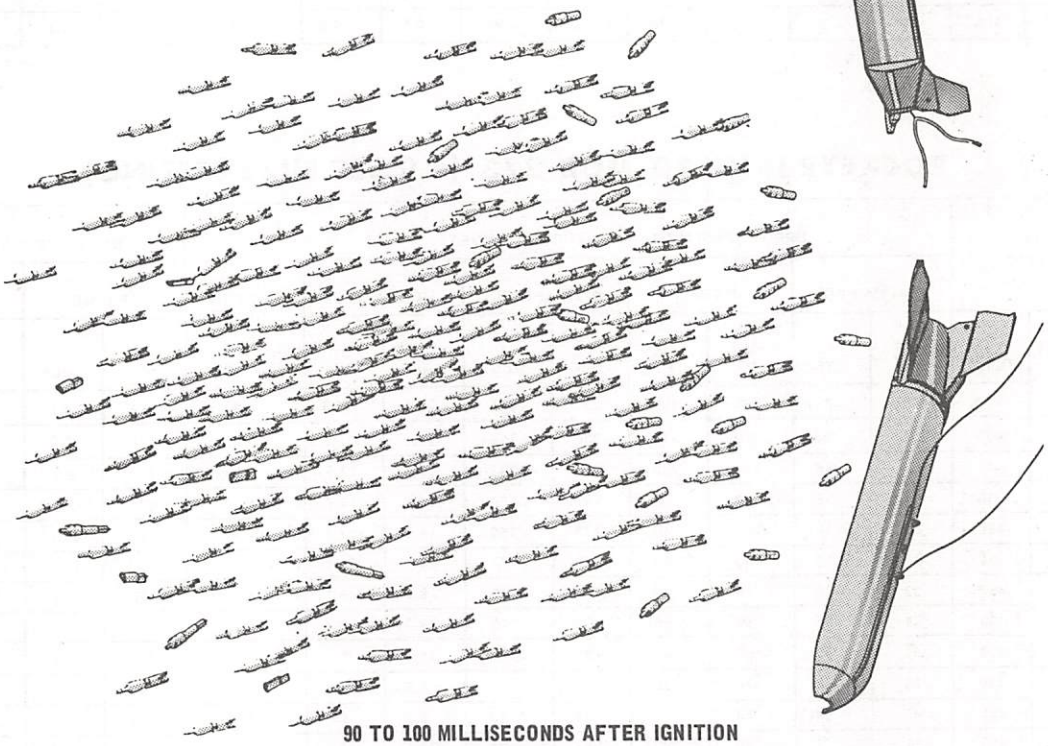


Figure 2-93 (C) (Sheet 2 of 20)

ROCKEYE II-CONTINUED



45 TO 60 MILLISECONDS AFTER IGNITION



90 TO 100 MILLISECONDS AFTER IGNITION

CONFIDENTIAL

FDB-1T-(186-4)

Figure 2-93 (C) (Sheet 3 of 20)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

ROCKEYE II MK 20 MOD 2/3 (1.2 SEC FUZE SETTING)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: +LONG, -SHORT)									RELATIVE WIND – 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	400	450	47	-49	-520	460	218	-329	22.0	-23.7	3.0	96	4.2	96	32.1
	600	450	50	-51	-410	380	211	-285	19.4	-20.5	3.5	124	6.2	125	35.6
	1000	450	52	-53	-290	280	193	-235	16.1	-16.8	4.1	166	10.1	168	40.9
10°	1000	450	35	-35	-160	140	79	- 99	10.3	-10.6	3.2	106	10.1	105	32.7
	1500	450	42	-42	-150	140	100	-117	10.4	-10.6	4.0	151	14.4	153	38.2
	2000	450	46	-46	-140	130	109	-123	10.2	-10.4	4.5	193	18.7	191	42.4
30°	3000	450	32	-32	- 60	60	48	- 53	6.7	- 6.8	4.5	173	25.7	174	38.6
	4000	450	39	-38	- 60	60	66	- 71	7.6	- 7.7	5.5	241	31.5	239	43.4
	5000	450	43	-43	- 60	60	81	- 85	8.3	- 8.4	6.5	302	36.2	304	46.8
45°	4000	450	25	-25	- 40	30	35	- 38	5.9	- 6.0	4.9	188	31.6	189	38.6
	6000	450	34	-34	- 40	40	64	- 67	7.8	- 7.8	6.8	309	39.6	307	45.2
	8000	450	39	-39	- 30	30	93	- 96	9.6	- 9.6	8.8	426	44.4	428	48.6

ROCKEYE II MK20 MOD 2/3 (4.0 SEC FUZE SETTING)

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: +LONG, -SHORT)									RELATIVE WIND – 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 Ft	FT	MILS	FT	MILS
0°	800	450	80	-83	-390	360	271	-383	27.6	-29.3	4.8	134	4.7	135	28.1
	1200	450	83	-87	-320	310	280	-355	24.5	-25.7	5.5	176	7.0	177	32.1
	1500	450	85	-88	-290	280	274	-333	22.6	-23.5	5.9	205	8.9	205	34.7
10°	1500	450	54	-56	-140	120	100	-127	14.4	-14.8	4.7	124	8.5	125	26.7
	2000	450	64	-66	-150	140	133	-159	14.8	-15.2	5.5	167	11.1	168	30.6
	2500	450	70	-72	-150	140	152	-175	14.7	-15.1	6.1	207	13.9	207	34.0
30°	3000	450	32	-32	- 40	40	37	- 42	8.0	- 8.1	4.9	128	15.9	128	26.2
	4000	450	48	-46	- 60	60	63	- 70	9.3	- 9.4	6.1	191	20.4	191	31.3
	5000	450	59	-56	- 60	60	85	- 92	10.2	-10.3	7.2	256	25.0	258	35.8
45°	4000	450	23	-24	- 20	20	24	- 26	6.6	- 6.6	5.1	134	20.3	133	26.0
	6000	450	45	-44	- 40	40	56	- 60	8.7	- 8.8	7.3	248	28.3	249	34.1
	8000	450	56	-55	- 40	40	87	- 91	10.5	-10.6	9.2	367	34.8	367	39.9
60°	6000	500	22	-23	- 20	20	27	- 29	7.3	- 7.3	6.6	182	24.9	181	27.5
	8000	500	35	-35	- 20	20	53	- 55	9.3	- 9.3	8.6	294	31.6	292	34.0

UNCLASSIFIED

FDB-1T-(186-6)

Figure 2-93 (C) (Sheet 4 of 20)

This page is UNCLASSIFIED

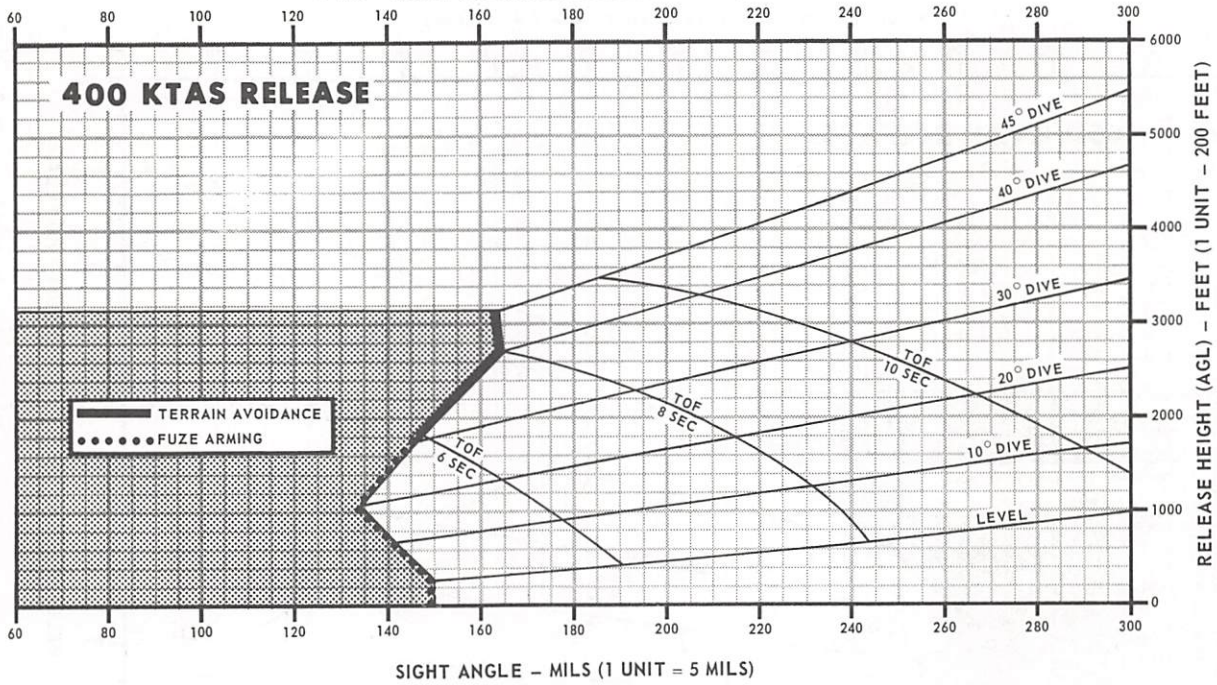
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

1.2 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE MILS	RECOVERY ALT (FT)
0	300	150	300
10	700	142	425
20	1100	134	400
FUZE / TERRAIN			
30	1775	147	500
40	2725	165	700
45	3150	164	700
50	3925	178	1000
60	4950	159	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(186–7)

Figure 2-93 (U) (Sheet 5 of 20)

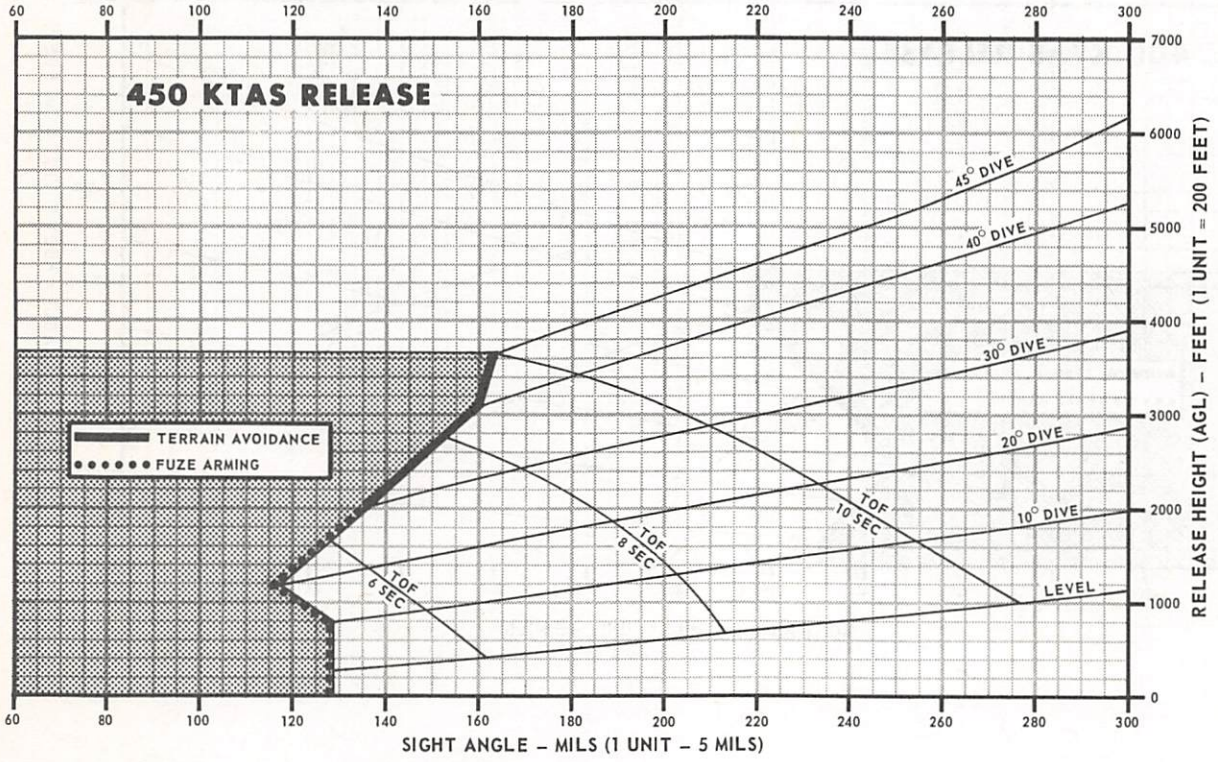
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

1.2 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

	DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
	0	300	129	300
	10	800	129	475
FUZE	20	1200	117	375
TERRAIN	30	2025	137	500
	40	3125	161	700
	45	3650	164	700
	50	4525	180	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(186–16)

Figure 2-93 (U) (Sheet 6 of 20)

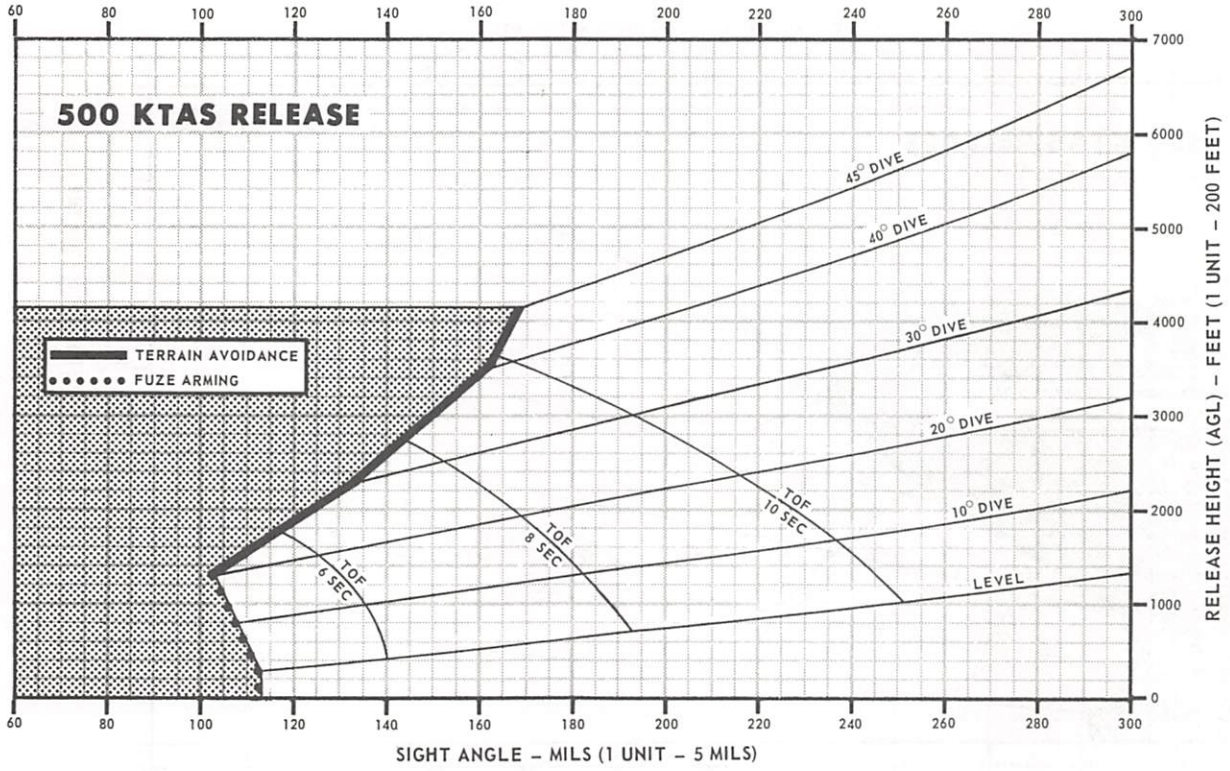
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

1.2 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	300	113	300
10	800	108	450
20	1300	104	350
FUZE TERRAIN			
30	2300	134	500
40	3550	163	700
45	4175	169	700
50	5125	185	1000
60	6600	173	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(186–8)

Figure 2-93 (U) (Sheet 7 of 20)

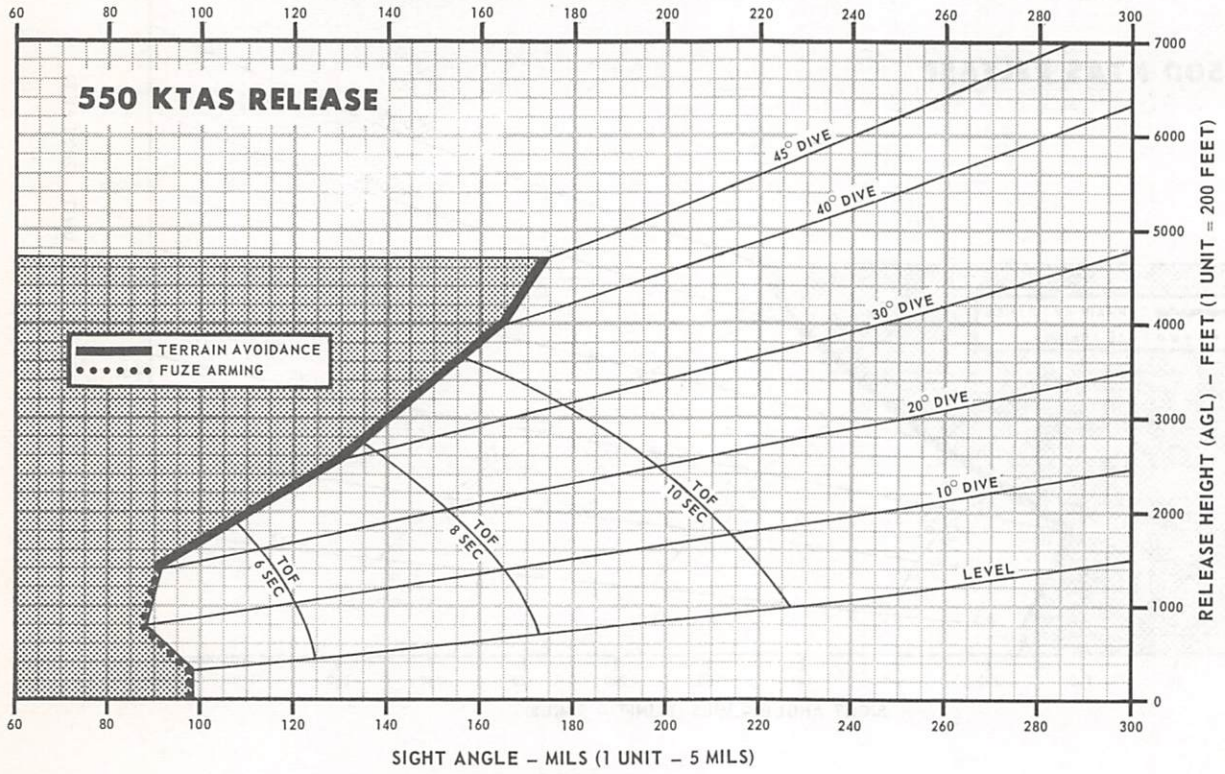
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

1.2 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	300	99	300
10	800	89	400
FUZE / TERRAIN			
20	1400	93	300
30	2550	130	500
40	3975	165	700
45	4675	174	700
50	5725	192	1000
60	7350	179	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB-1T-(186-17)

Figure 2-93 (U) (Sheet 8 of 20)

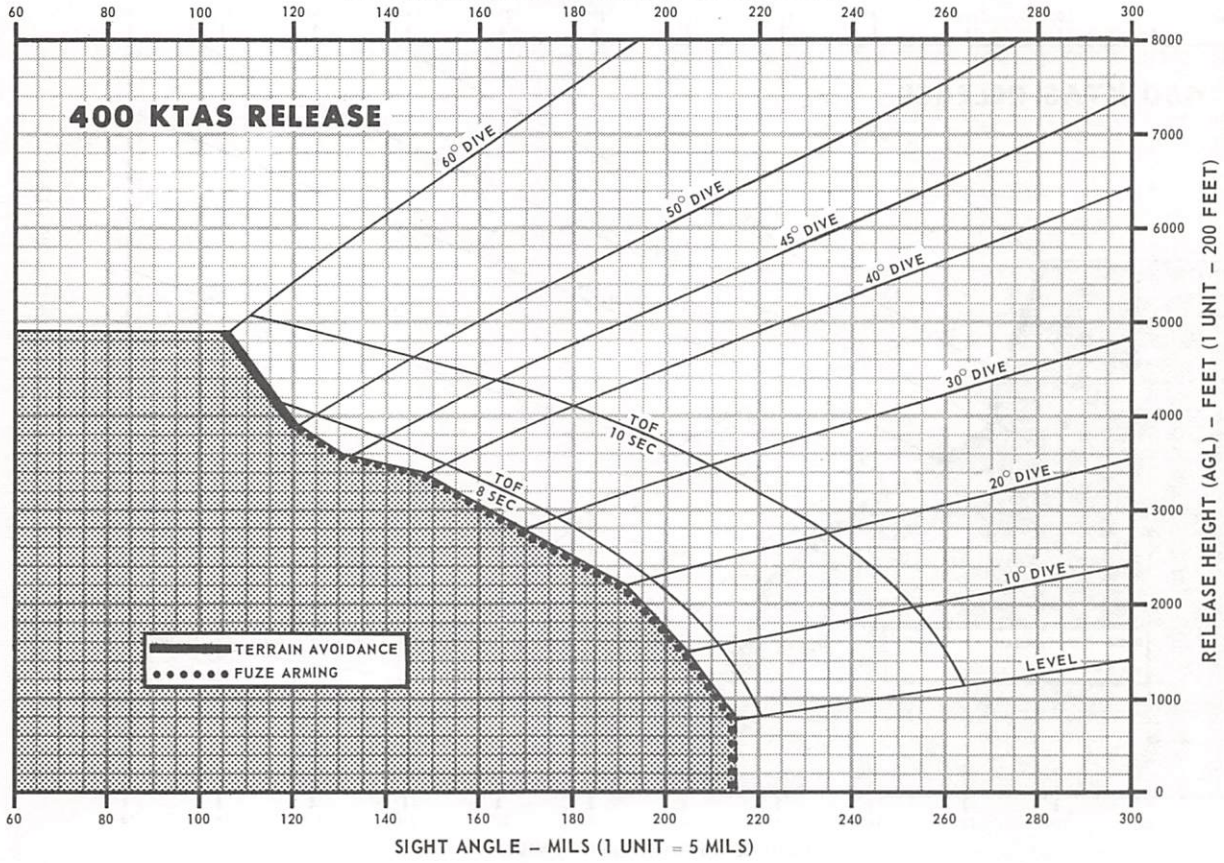
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

4.0 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	800	215	800
10	1500	204	1225
20	2200	191	1500
30	2800	169	1525
40	3400	147	1375
45	3600	131	1150
FUZE / TERRAIN			
50	3925	121	1000
60	4950	106	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(186–9)

Figure 2-93 (U) (Sheet 9 of 20)

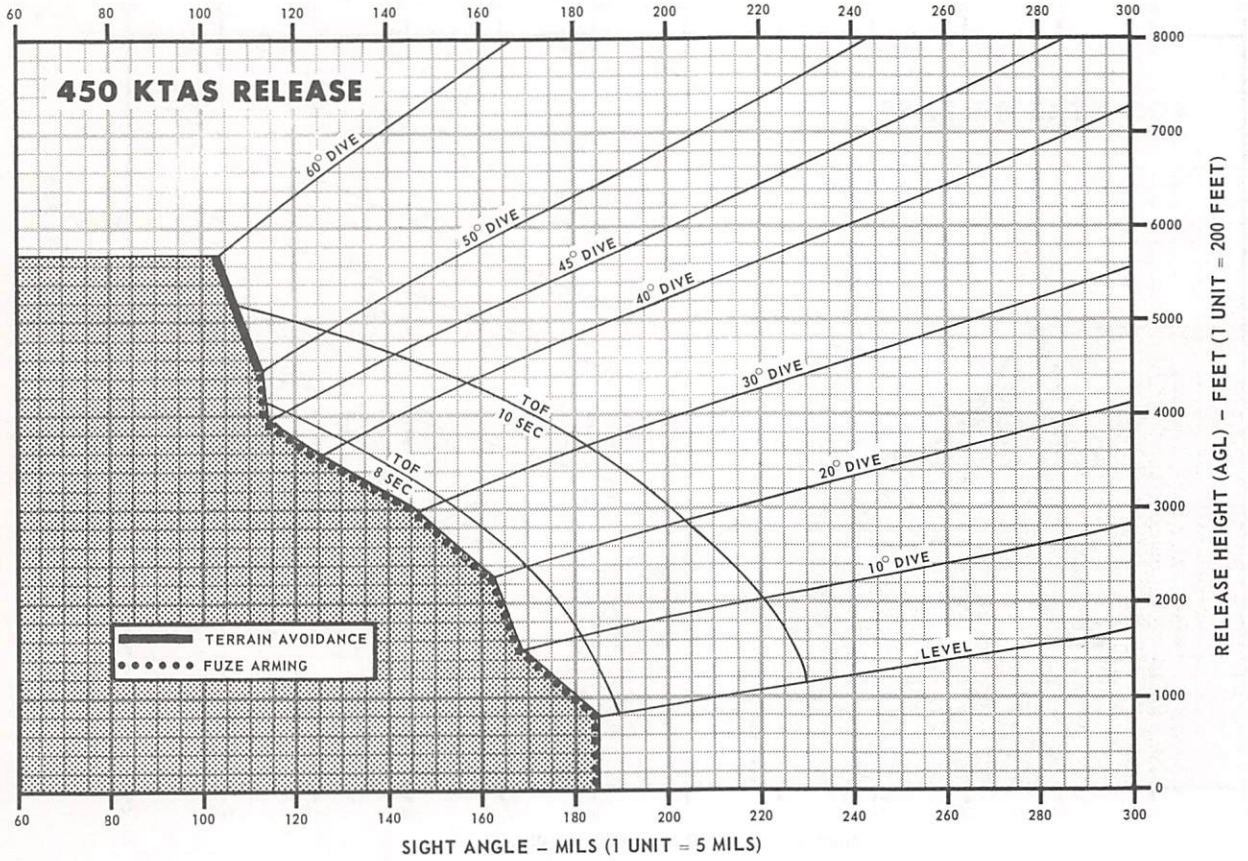
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

4.0 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	800	185	800
10	1500	168	1175
20	2300	162	1475
30	3000	146	1475
40	3600	125	1175
FUZE 45	3900	114	950
TERRAIN 50	4525	113	1000
60	5750	103	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(186–10)

Figure 2-93 (U) (Sheet 10 of 20)

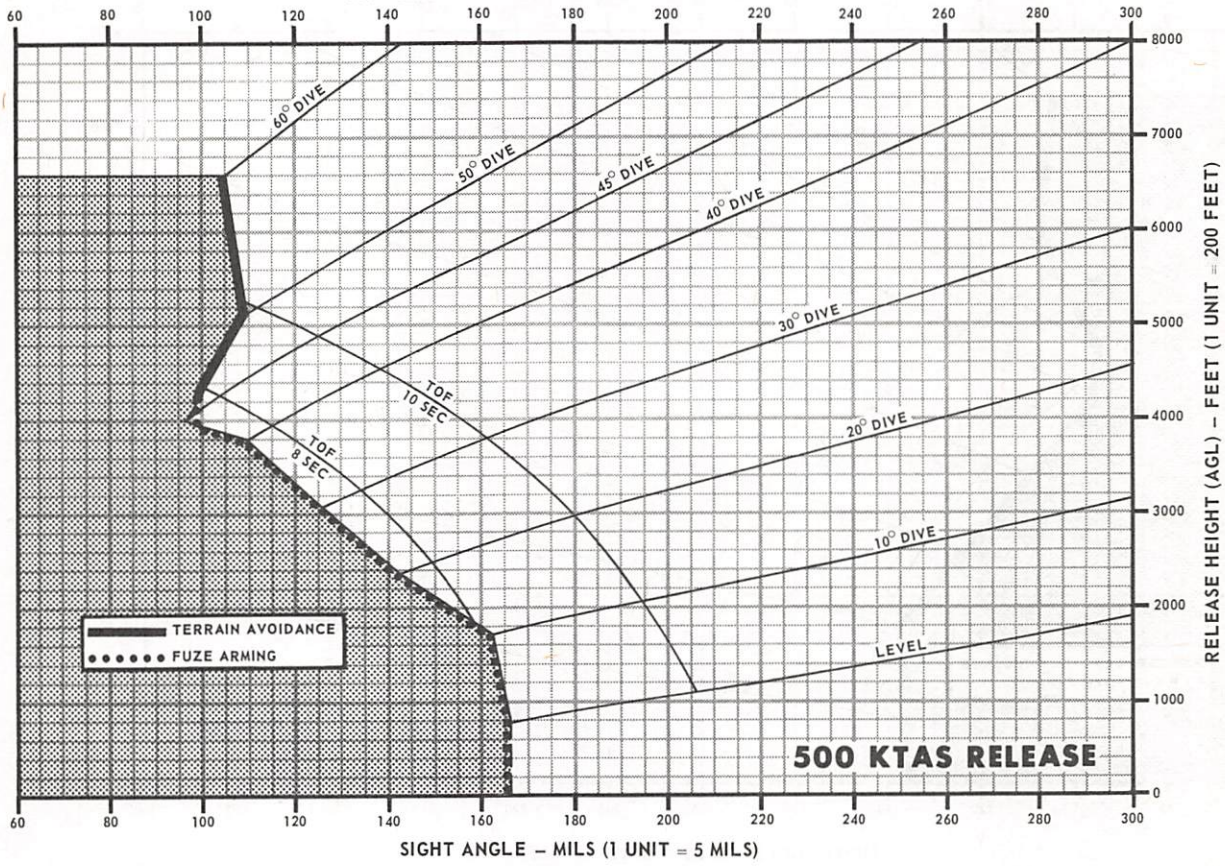
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

4.0 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	800	166	800
10	1700	162	1350
20	2400	143	1450
30	3100	125	1300
40	3800	110	950
FUZE 45	4100	98	625
TERRAIN 50	5125	109	1000
60	6600	105	1000

WEAPON BALLISTIC REFERENCE WEIGHT AND EJECTION VELOCITY: ROCKEYE II: 475 LBS/6.0 FPS

UNCLASSIFIED

FDB–1T–(186–11)

Figure 2-93 (U) (Sheet 11 of 20)

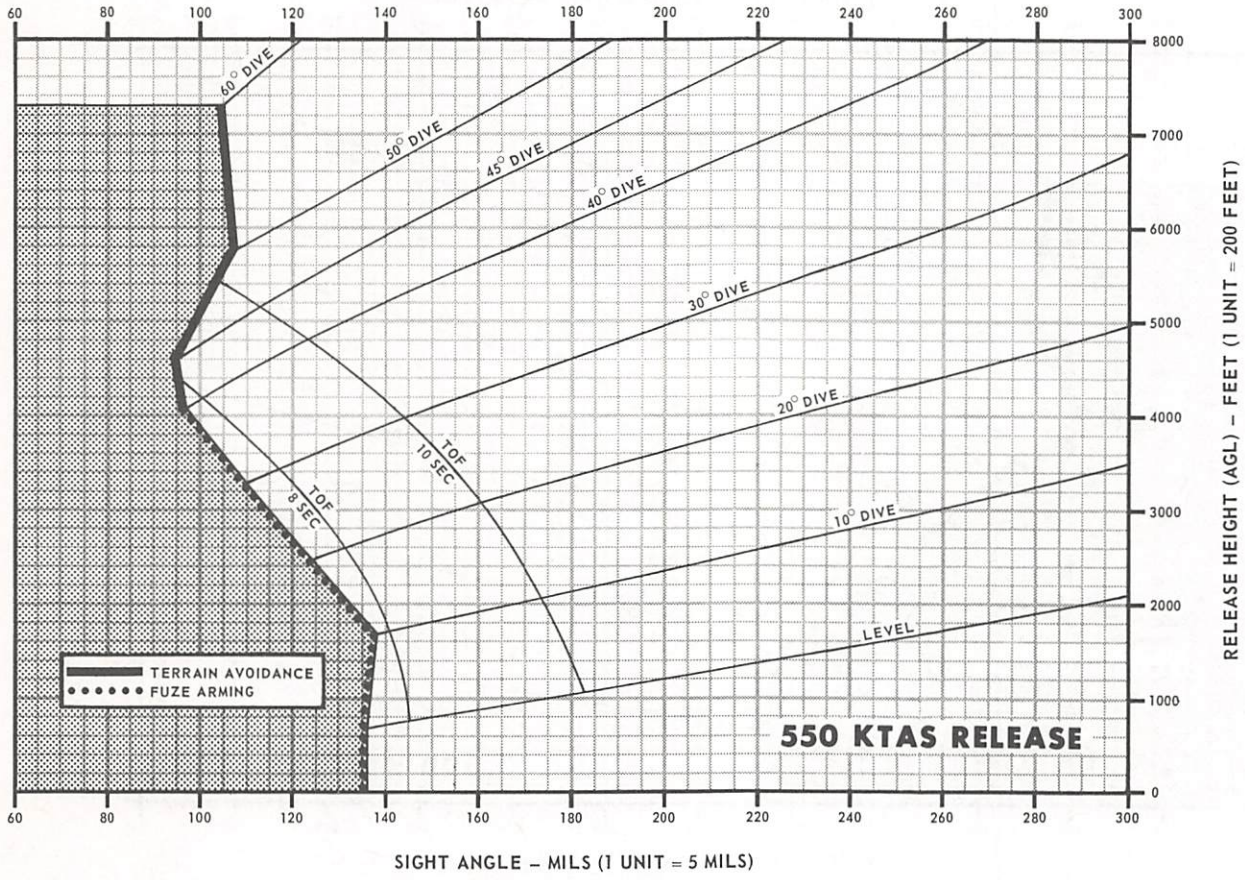
SIGHT ANGLE

ROCKEYE II MK 20 MOD 2/3

4.0 SEC FUZE SETTING

Notes

- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT. SINGLE BOMB RELEASE, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, AND 6.0 FEET PER SECOND AVERAGE EJECTION VELOCITY. PARALLAX CORRECTION IS INCLUDED.
- MINIMUM RELEASE HEIGHT FOR FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER LAST BOMB RELEASE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT PILOT RESPONSE DELAY IS INCLUDED.
- TOF = TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



NEW NEW NEW

DIVE ANGLE (DEG)	MIN REL ALT (FT)	SIGHT ANGLE (MILS)	RECOVERY ALT (FT)
0	700	136	700
10	1700	138	1300
20	2500	124	1400
30	3300	110	1250
FUZE 40	4100	97	825
TERRAIN 45	4675	96	700
50	5725	107	1000
60	7350	105	1000

WEAPON BALLISTIC REFERENCE
WEIGHT AND EJECTION VELOCITY:
ROCKEYE II: 475 LBS/6.0 FPS

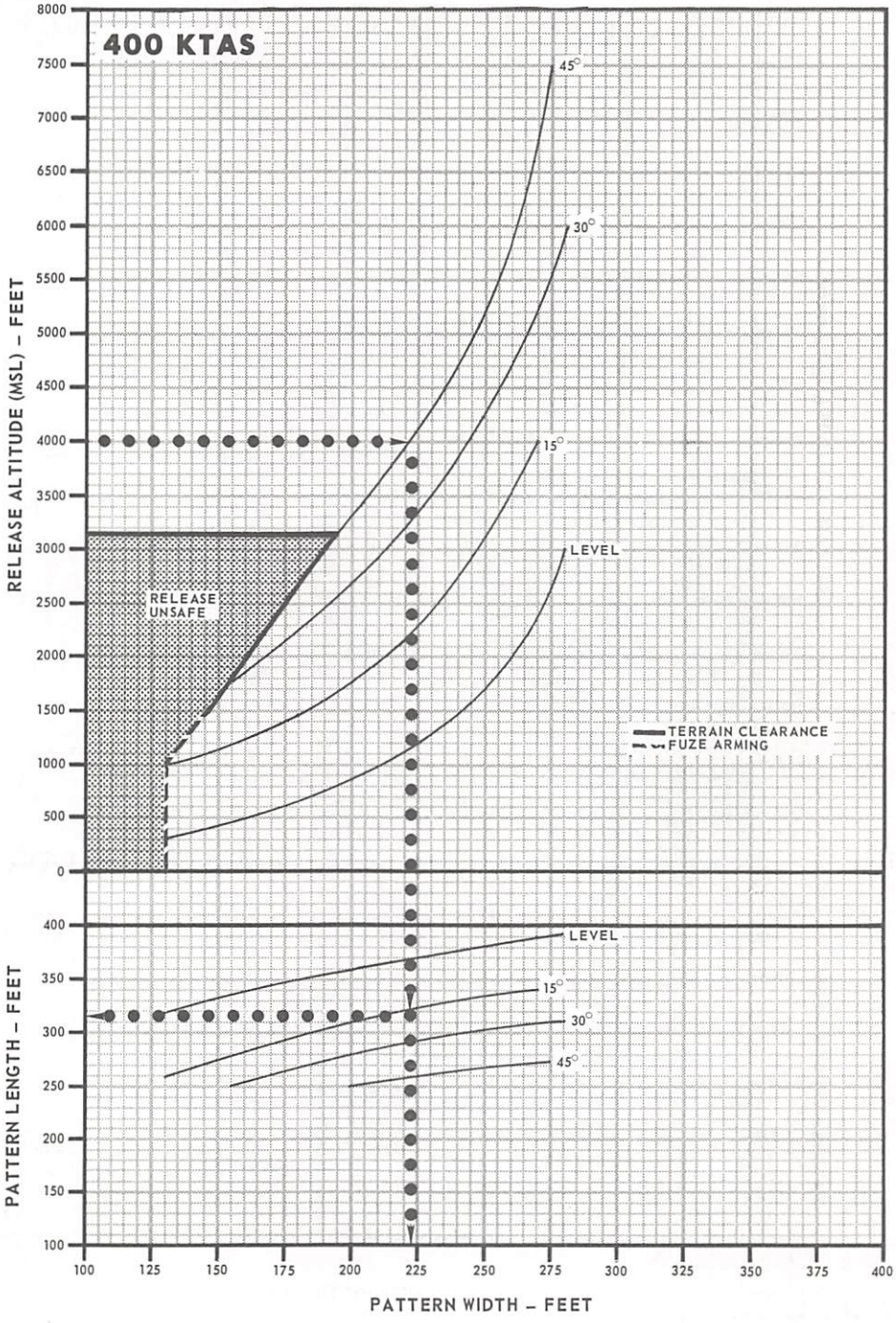
UNCLASSIFIED

FDB–1T–(186–12)

Figure 2-93 (U) (Sheet 12 of 20)

ROCKEYE II IMPACT PATTERNS

1.2 SEC FUZE SETTING



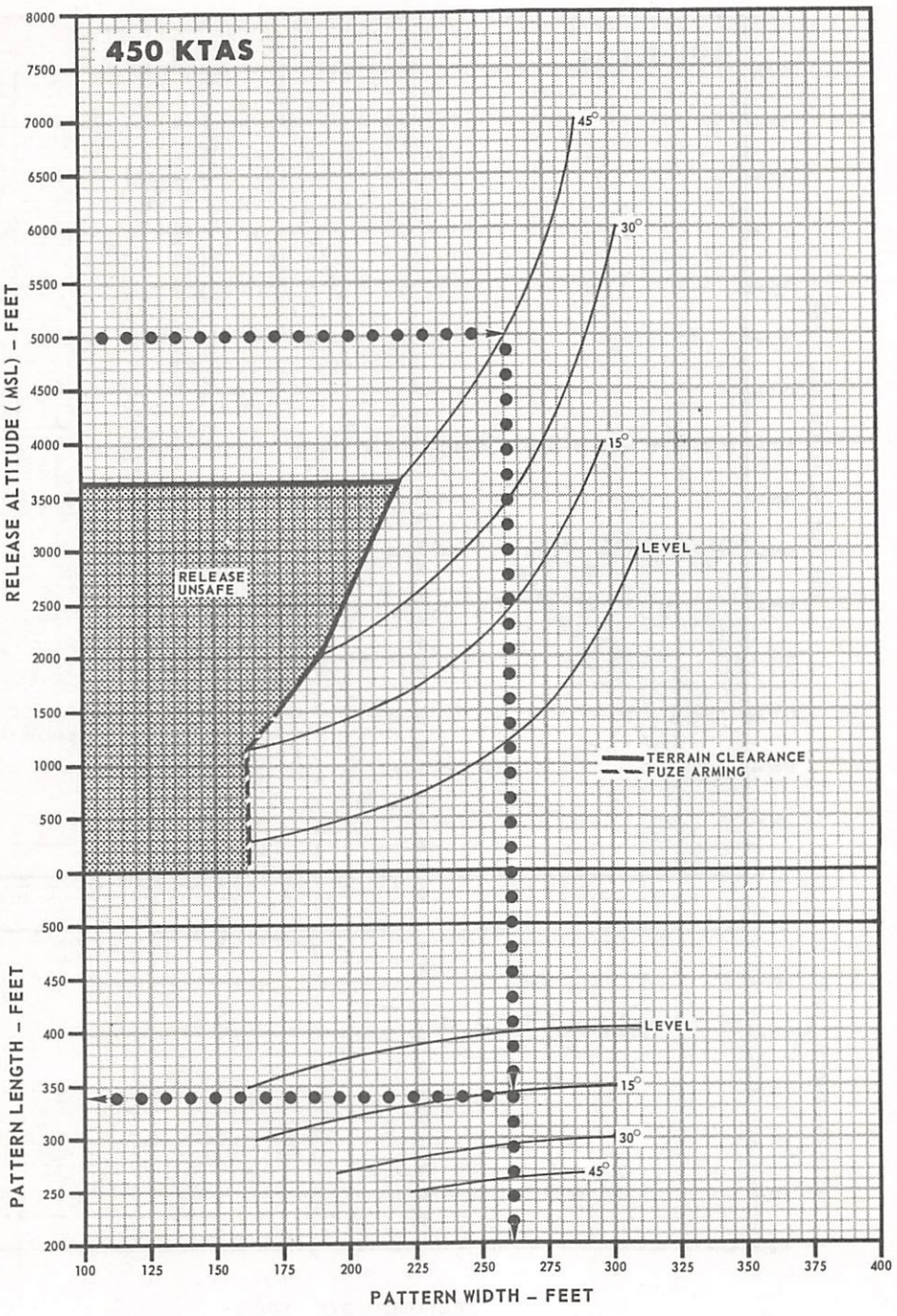
CONFIDENTIAL

FDB-1T-(186-18)

Figure 2-93 ((C) (Sheet 13 of 20)

ROCKEYE II IMPACT PATTERNS-CONTINUED

1.2 SEC FUZE SETTING



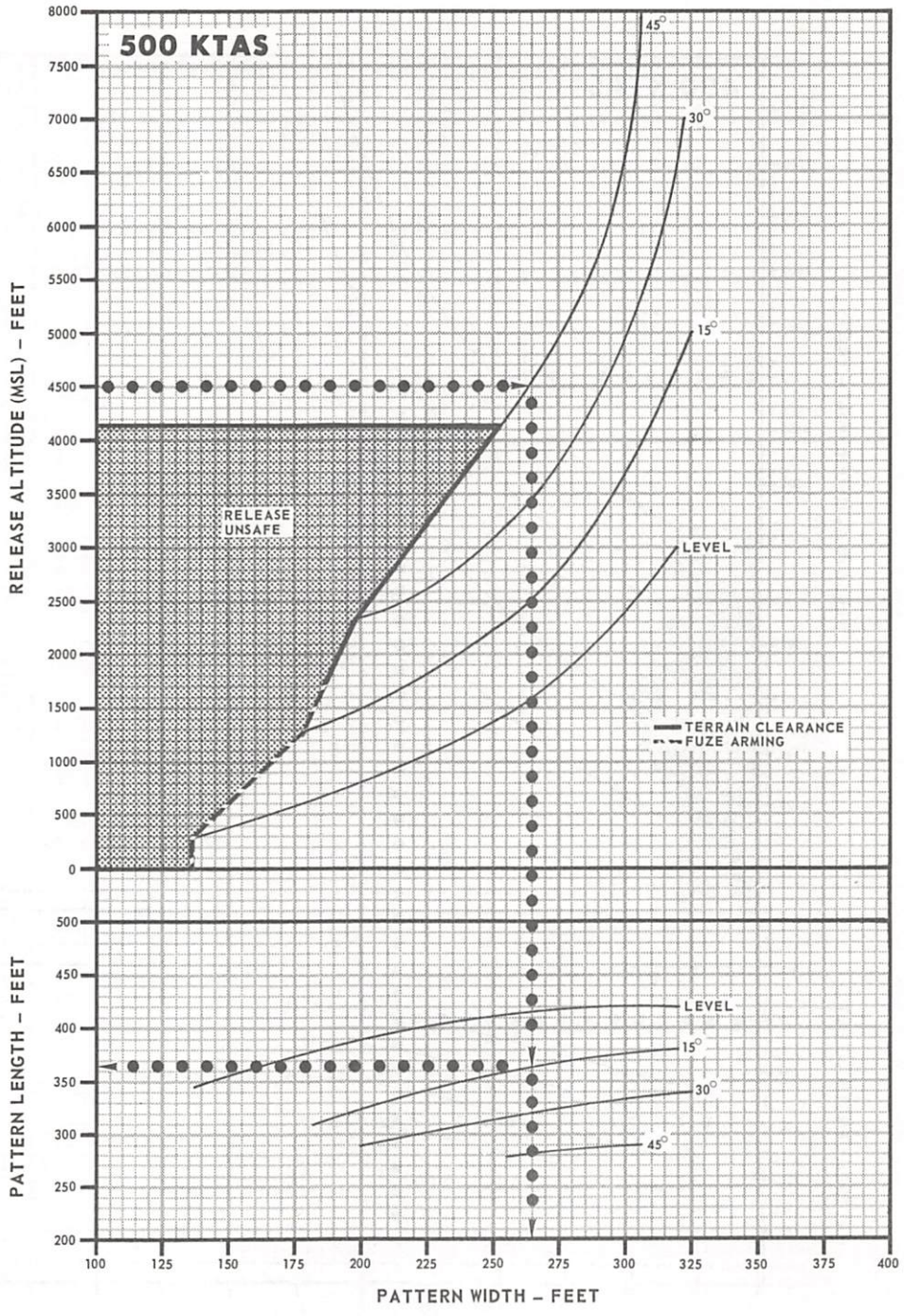
CONFIDENTIAL

FDB-1T-(186-19)

Figure 2-93 (C) (Sheet 14 of 20)

ROCKEYE II IMPACT PATTERNS-CONTINUED

1.2 SEC FUZE SETTING



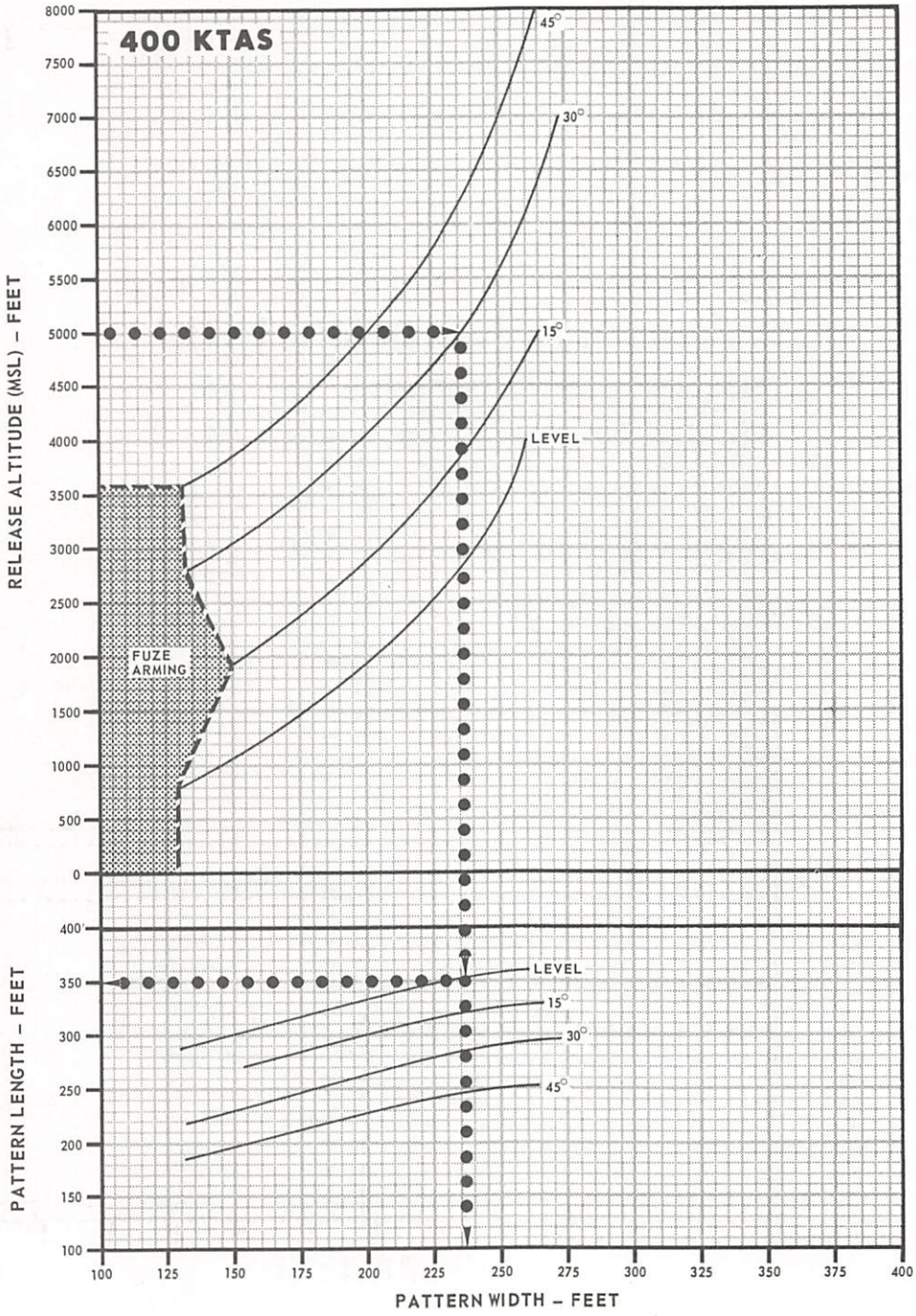
CONFIDENTIAL

FDB-1T-(186-20)

Figure 2-93 (C) (Sheet 15 of 20)

ROCKEYE II IMPACT PATTERNS-CONTINUED

4.0 SEC FUZE SETTING



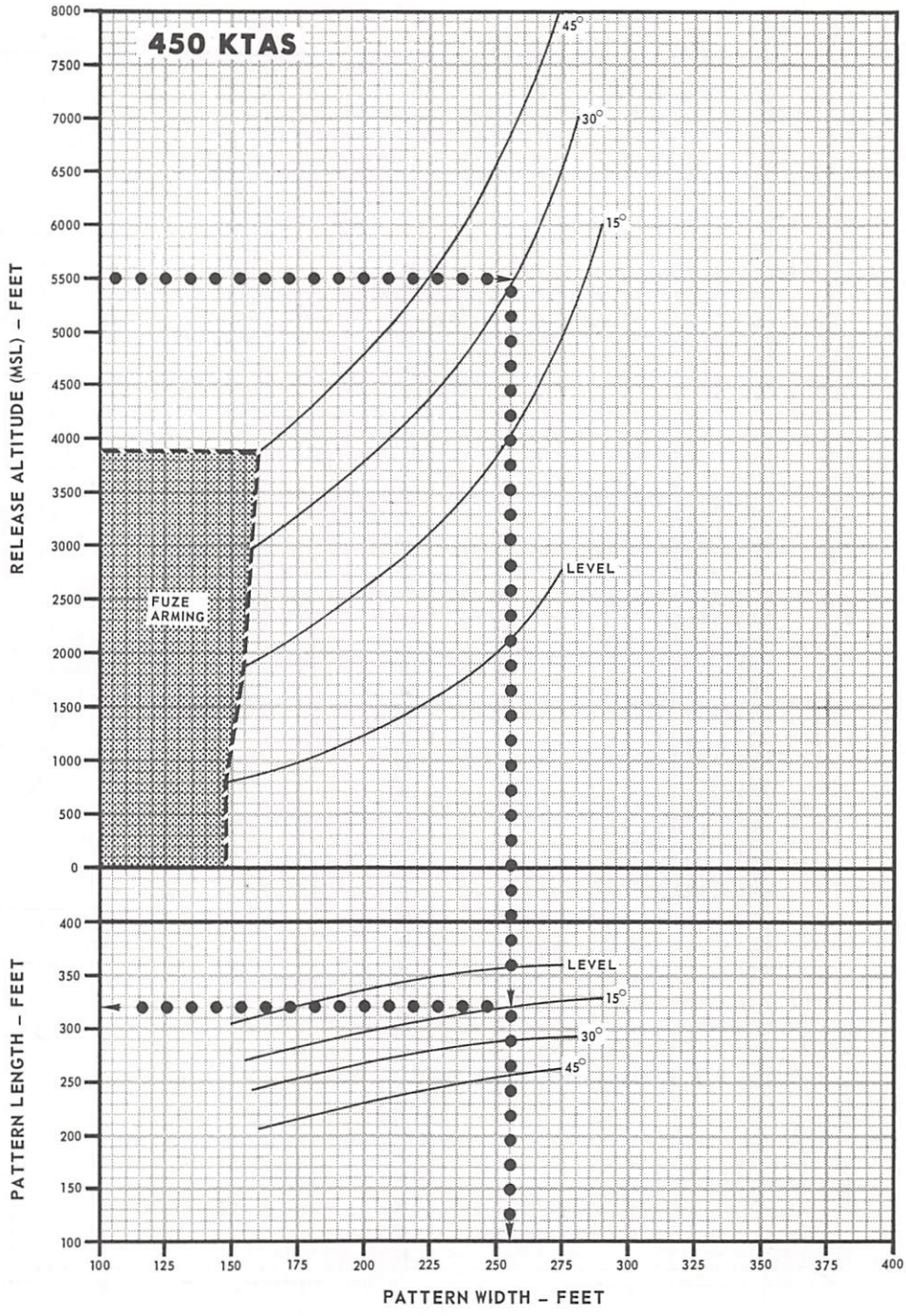
CONFIDENTIAL

FDB-1T-(186-21)

Figure 2-93 (C) (Sheet 16 of 20)

ROCKEYE II IMPACT PATTERNS-CONTINUED

4.0 SEC FUZE SETTING



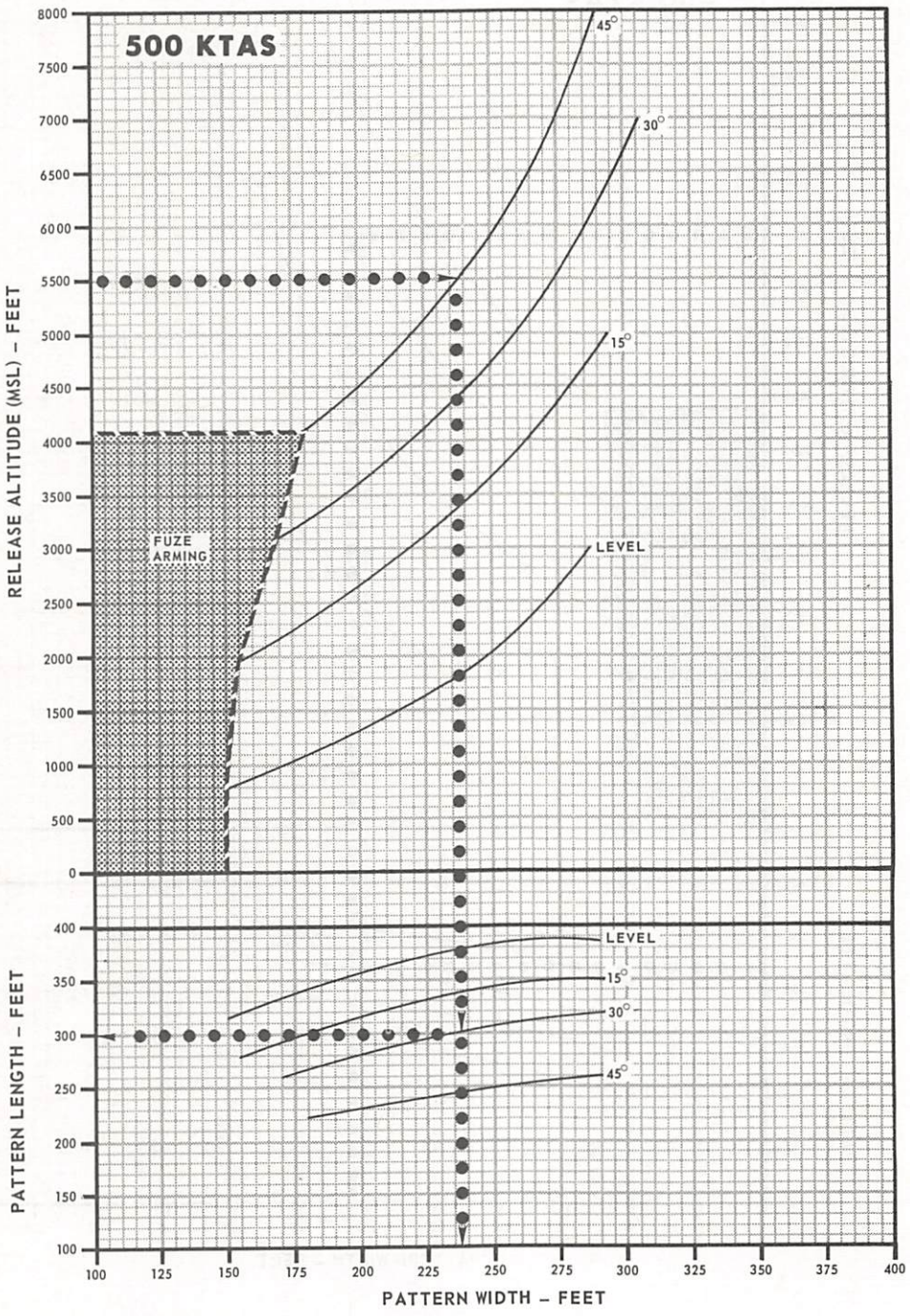
CONFIDENTIAL

FDB-1T-(186-22)

Figure 2-93 (C) (Sheet 17 of 20)

ROCKEYE II IMPACT PATTERNS-CONTINUED

4.0 SEC FUZE SETTING



CONFIDENTIAL

FDB-1T-(186-23)

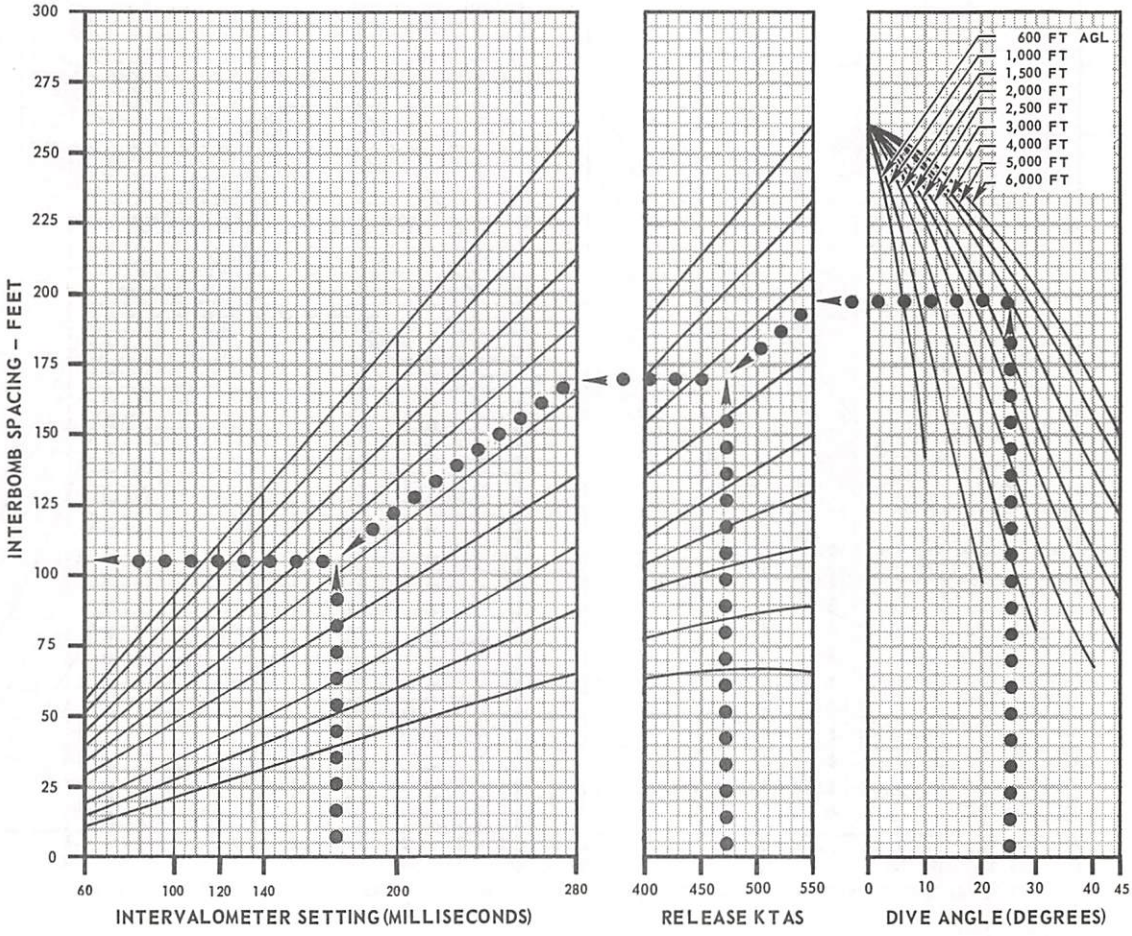
Figure 2-93 (C) (Sheet 18 of 20)

BOMB SPACING

ROCKEYE II MK 20 MOD 2

1.2 SEC FUZE SETTING

NOTE
USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB
(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 6.9 FT/SEC)



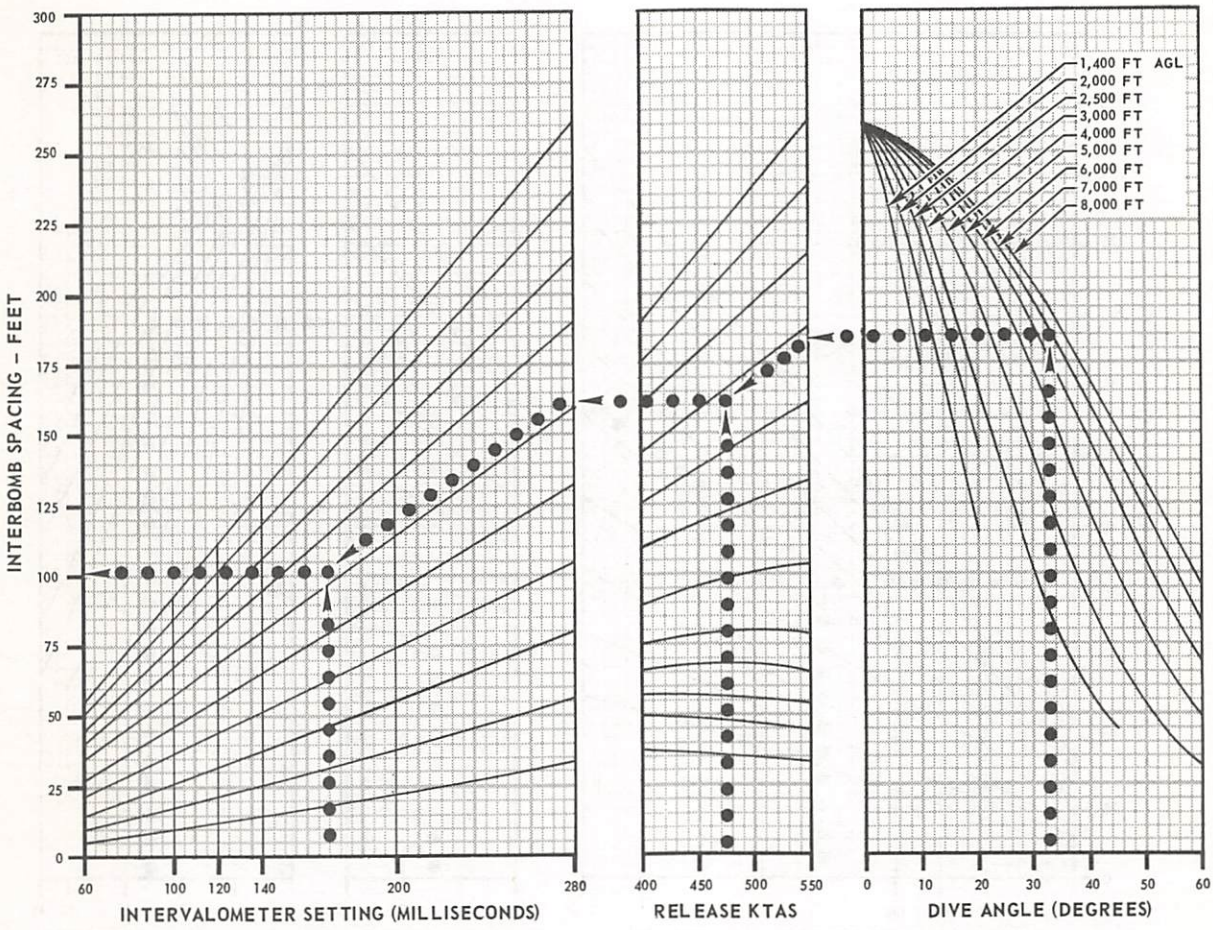
UNCLASSIFIED
FDB-1T-(186-13)

Figure 2-93 (U) (Sheet 19 of 20)

BOMB SPACING
ROCKEYE II MK 20 MOD 2/3
4.0 SEC FUZE SETTING

NOTE
USE RELEASE HEIGHT AND
RELEASE AIRSPEED OF LAST BOMB

(BASED ON SIX BOMB RIPPLE RELEASE,
MER-TER EJECTION VELOCITY 6.0 FT/SEC)

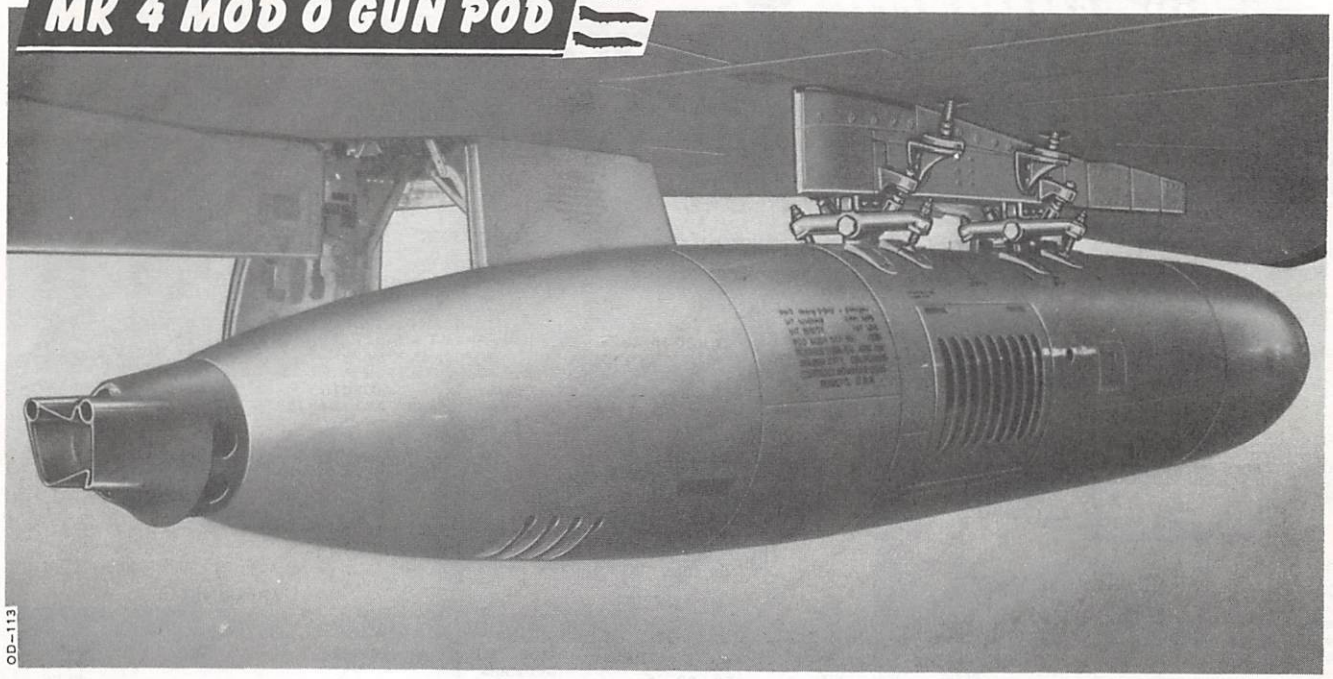


UNCLASSIFIED

FDB-1T-(186-14)

Figure 2-93 (U) (Sheet 20 of 20)

MK 4 MOD 0 GUN POD



OD-113

CHARACTERISTICS	
OVERALL LENGTH	189.4 INCHES
DIAMETER	22.5 INCHES
WEIGHT LOADED	1,390.0 POUNDS
WEIGHT EMPTY	787.0 POUNDS
CAPACITY	750.0 ROUNDS
FAST FIRE RATE	4,000 RDS/MIN
SLOW FIRE RATE	700 RDS/MIN

FIRING BURST LENGTH SCHEDULES

BURST LENGTH	COOLING TIME BETWEEN BURSTS
0.5 SECOND	45.0 SECONDS
1.0 SECOND	1.5 MINUTES
1.5 SECONDS	2.5 MINUTES
2.0 SECONDS	3.25 MINUTES
UP TO 5.0 SECONDS	

Note: If the total time for a fireout is not less than 15 minutes, the pod will be cookoff safe.

DESCRIPTION

The MK 4 Gun Pod is a self-powered, self-contained 20mm gun system providing air-to-ground and air-to-air capabilities. The pod is composed of the MK 11 gun and the pod assembly. The MK 11 gun is a twin-barrel, air-cooled, belt-fed, combination gun gas and recoil-operated gun. It fires electrically primed ammunition from an eight-chamber cylinder and features two selectable rates of fire, 4000 round per minute and 700 rounds per minute. Muzzle velocity is 3300 feet per second. The pod assembly houses the MK 11 gun with its' associated equipment and a maximum of 750 rounds of belted ammunition. The gun pod attachment lugs and sway brace pads are adjustable for 14 inch or 30 inch suspension to accomodate various types of aircraft. To assist in boresighting, the aft lug is adjustable for deflection errors and the forward lug is adjustable for errors in elevation.

REFERENCES

1. Gunnery Equipment . . . . . Section II, Part 1
2. Operation . . . . . NAVAIR 11-95-8
3. Loading . . . . . NAVAIR 01-245FDB-75
4. Boresighting . . . . . NAVAIR 01-245FDB-2-7
5. External Store Limitations . . . . . APPENDIX A
6. Current AAB's.
7. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-17.1

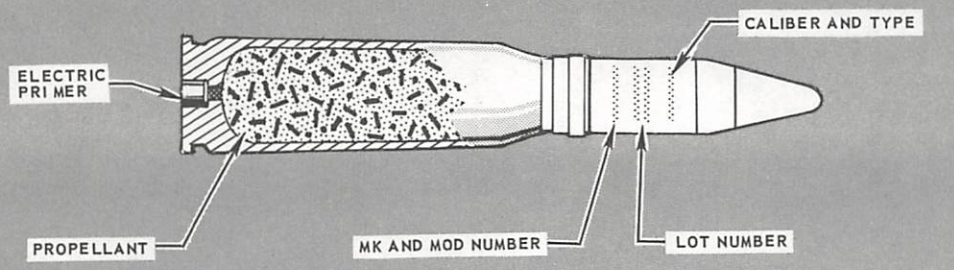
UNCLASSIFIED

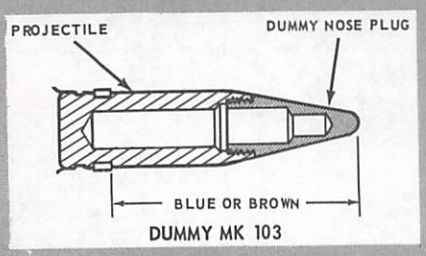
FDB-1T-(187-1)

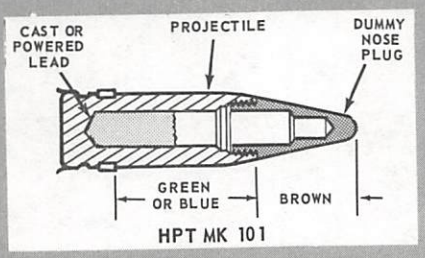
Figure 2-94 (U) (Sheet 1 of 12)

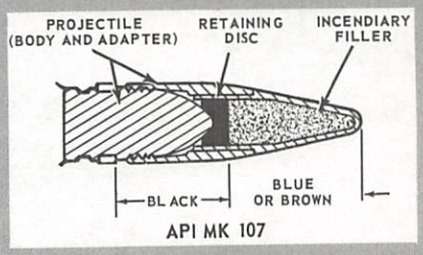
20MM AMMUNITION

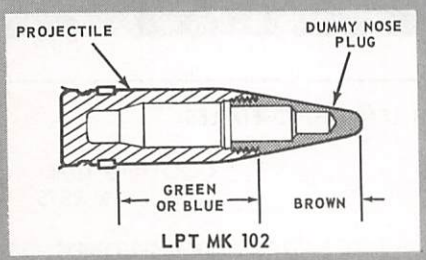
MK 4 GUN POD, MK 11 GUN

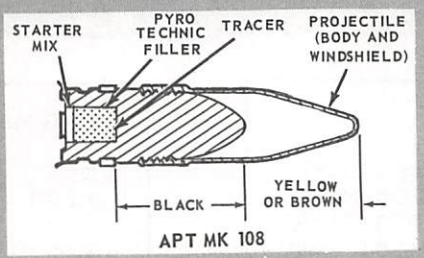


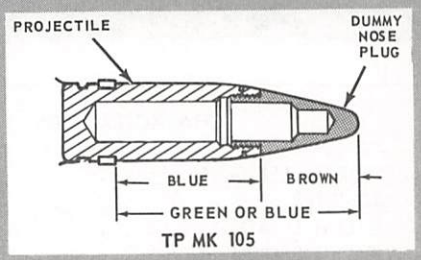


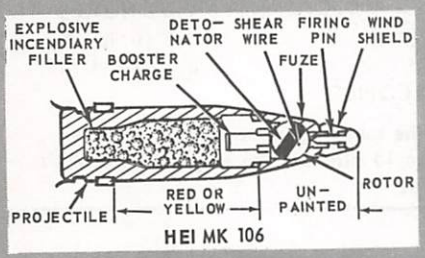












API – ARMOR PIERCING–INCENDIARY
APT – ARMOR PIERCING WITH TRACER
HEI – HIGH EXPLOSIVE INCENDIARY
HPT – HIGH PRESSURE TEST
LPT – LOW PRESSURE TEST
TP – TARGET PRACTICE

DESCRIPTION

The ammunition used by the MK–11 gun is 20mm MK 100 series. Each type is identified by marking and color code as illustrated. All types are electrically primed, have a steel cartridge case, have matched ballistics, and are approximately the same in shape, length, and weight.

WARNING

The explosive elements in electric primers are highly sensitive to electrostatic charges and care should be exercised to prevent the primer button from coming in contact with static charges built up on the human body or other sources of electricity.

The MK 101 High Pressure Test (HPT) round and the MK 102 Low Pressure Test round are used primarily for testing new production guns. The projectile contains no explosive.

The MK 103 Dummy round contains no explosive charge in either the projectile or cartridge case. The round is used for loading practice and function testing of gun pod feed mechanisms.

The MK 105 Target Practice (TP) round has no explosive in the projectile and has a dummy nose plug in place of a fuze.

The MK 106 High Explosive Incendinary (HEI) round has the MK 12 projectile. The projectile is loaded with tetryl and incending composition. The projectile provides a high explosive blast plus a fire starter. The fuze is a rotor type and functions instantaneous at impact. A soft copper shear wire prevents the rotor from rotating the detonator into line with the firing pin until the round is fired.

WARNING

Fuzes shall not be disassemblied. Detonation may result.

The MK 107 Armor Piercing Incendiary (API) projectile has a solid steel armor piercing body with an aluminum nose piece containing an incendiary filler. The incendiary charge ignites at impact.

The MK 108 Armor Piercing Tracer (APT) projectile has an empty nose faring on a steel armor piercing body. The steel body is shaped like the API body except for center cavity which contains a tracer mixture. The tracer charge is ignited by the heat produced by the propellant. The tracer burns with a reddish color and is visible for approximately 3800 feet of flight.

FDB–1T–(187–2)

UNCLASSIFIED

Figure 2-94 (U) (Sheet 2 of 12)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

*MK 4 GUN POD

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: + LONG, - SHORT)									RELATIVE WIND - 10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE (DEG)	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	Slant Range 1000 FT	FT	MILS	FT	MILS
10	500	450	0	0	- 28	16	8	- 17	17.6	-18.7	3.0	16	0.9	17	5.5
	500	500	0	0	- 24	14	7	- 14	16.7	-17.7	2.9	15	0.9	15	5.3
	1000	450	3.2	-3.3	-101	74	64	-126	32.1	-33.9	5.7	46	1.4	45	7.9
	1000	500	3.1	-3.2	- 87	62	53	-105	30.8	-32.5	5.6	41	1.3	42	7.5
20	1000	450	0	0	- 6	4	2	- 3	8.8	- 9.1	3.0	16	1.8	17	5.5
	1200	500	0.2	-0.2	- 7	6	3	- 5	10.2	-10.5	3.5	20	1.9	20	5.7
	2000	450	1.7	-1.7	-25	21	20	- 29	16.9	-17.3	5.8	46	2.7	45	7.8
	2000	500	1.7	-1.7	-22	19	18	- 25	16.5	-17.0	5.8	44	2.6	44	7.5
	3000	450	6.2	-6.2	-56	52	71	- 94	23.0	-23.6	8.4	89	3.8	90	10.7
	3000	500	6.0	-6.1	-53	48	65	- 87	22.7	-23.3	8.3	85	3.7	85	10.3
30	2000	450	0	0	- 4	3	3	- 3	8.1	- 8.2	4.0	24	3.0	24	6.1
	2000	500	0.3	-0.3	- 4	3	2	- 3	7.9	- 8.1	4.0	24	3.0	24	5.9
	3000	450	1.2	-1.2	-11	10	10	- 13	11.9	-12.1	6.0	47	3.9	47	7.8
	3000	500	1.2	-1.3	-10	9	9	- 11	11.7	-11.9	5.9	45	3.8	44	7.5
45	4000	450	0.6	-0.6	- 3	3	3	- 4	7.9	-8.0	5.6	41	5.2	41	7.3
	4000	500	0.6	-0.6	- 3	3	3	- 4	7.9	- 8.0	5.6	40	5.0	39	7.0
60	7000	500	1.3	-1.3	- 4	4	6	- 6	9.2	- 9.2	8.0	74	8.0	73	9.1

NEW

*GUN BORE LINE PARALLEL TO FRL

UNCLASSIFIED

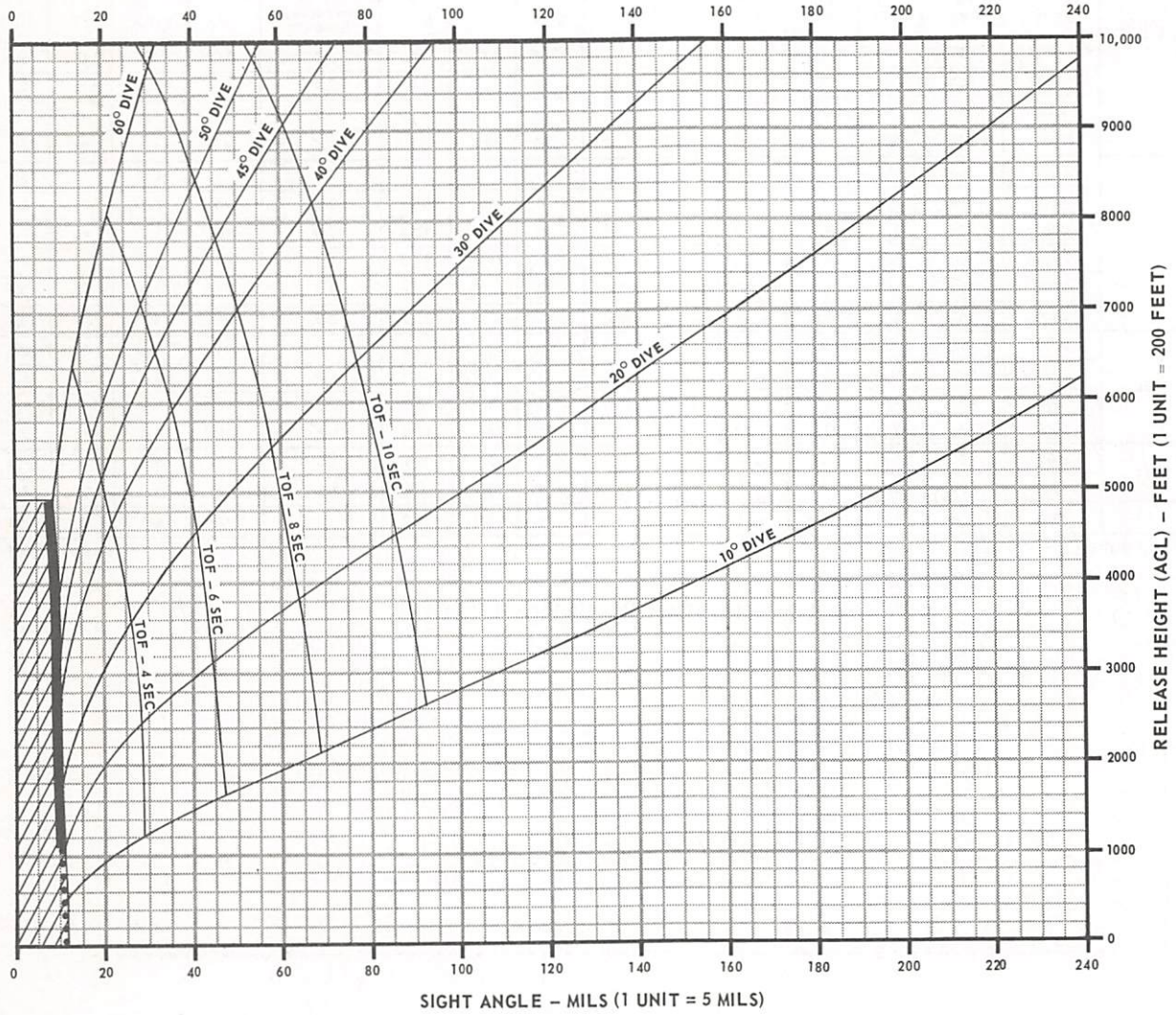
FDB-1T-(187-3)

Figure 2-94 (U) (Sheet 3 of 12)

SIGHT ANGLE
MK 4 GUN POD
400 KTAS RELEASE

Notes

- GUN BORE LINE PARALLEL TO FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0-SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF – TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

	DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
		1.5 SEC BURST			3.0 SEC BURST		
		CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
FRAG	10	550	12	275	550	12	275
	20	1050	11	350	1100	11	400
TERRAIN	30	1775	11	500	1775	11	500
	40	2725	11	700	2725	11	700
	45	3150	10	700	3150	10	700
	50	3925	10	1000	3925	10	1000
	60	4950	9	1000	4950	9	1000

0.000 HIT PROBABILITY TERRAIN AVOIDANCE

FDB-1T-(187-4)

UNCLASSIFIED

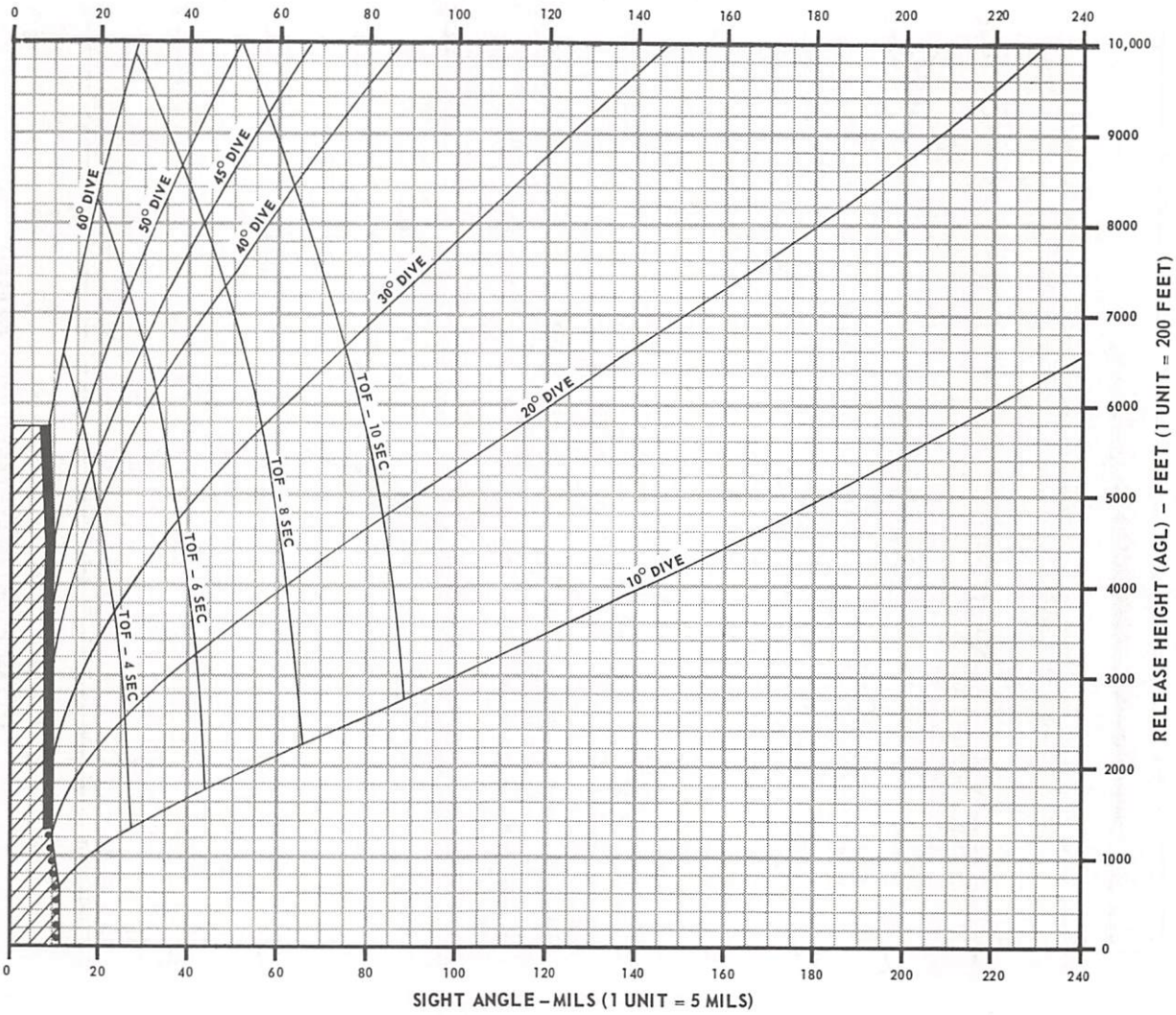
Figure 2-94 (U) (Sheet 4 of 12)

SIGHT ANGLE
MK 4 GUN POD
450 KTAS RELEASE

NEW

Notes

- GUN BORE LINE PARALLEL TO FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15–DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0–SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF – TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

NEW NEW NEW

DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
	1.5 SEC BURST			3.0 SEC BURST		
	CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
10	650	11	325	700	12	375
20	1200	10	375	1300	11	475
FRAG / TERRAIN 30	2025	10	500	2025	10	500
40	3125	10	700	3125	10	700
45	3650	10	700	3650	10	700
50	4525	11	1000	4525	11	1000
60	5750	9	1000	5750	9	1000

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

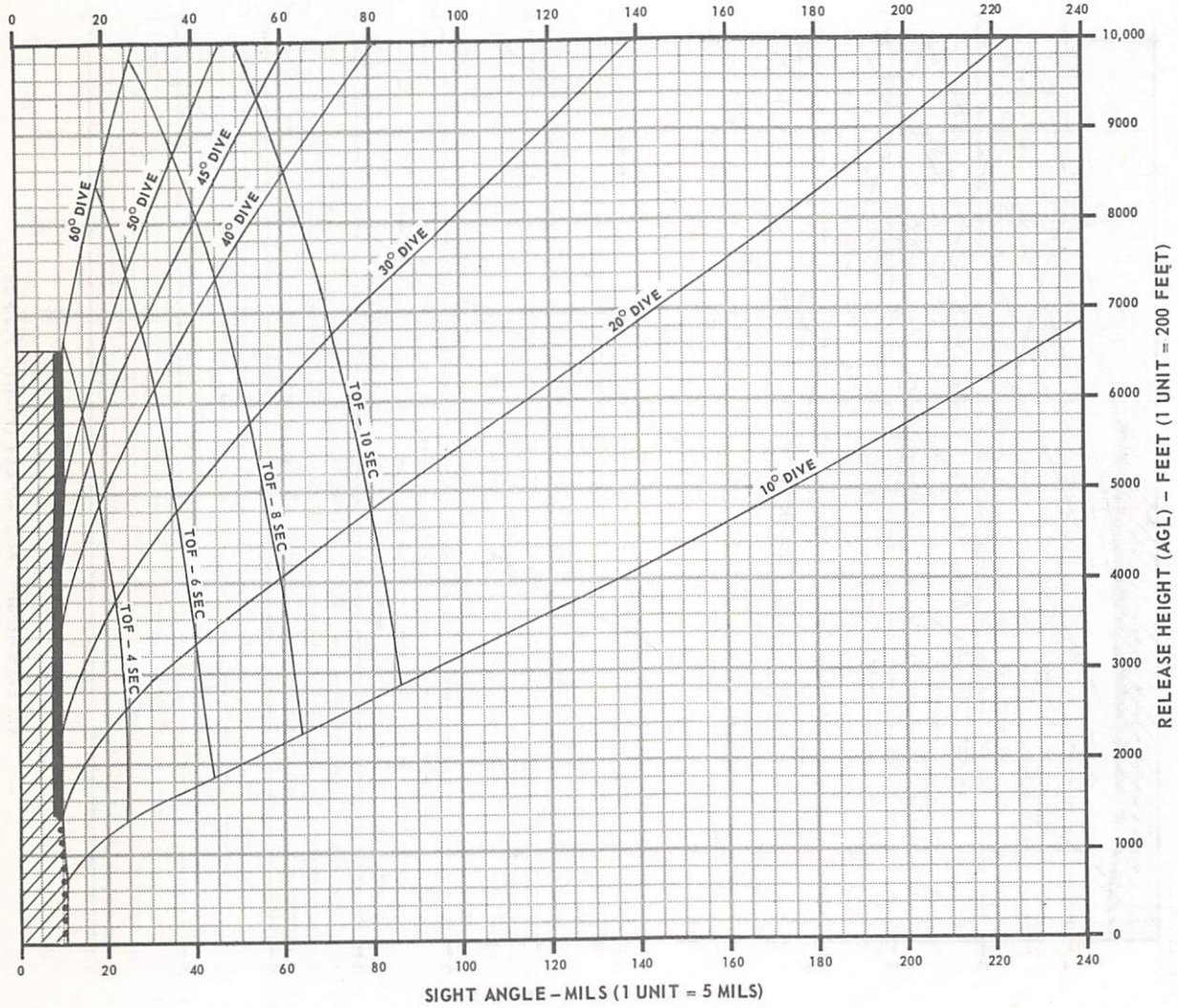
FDB–1T–(187–5)

Figure 2-94 (U) (Sheet 5 of 12)

SIGHT ANGLE
MK 4 GUN POD
500 KTAS RELEASE

Notes

- GUN BORE LINE PARALLEL TO FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0-SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF – TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
	1.5 SEC BURST			3.0 SEC BURST		
	CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
10	700	10	350	800	12	450
20	1400	10	450	1400	10	450
30	2300	10	500	2300	10	500
40	3550	11	700	3550	11	700
45	4175	11	700	4175	11	700
50	5125	11	1000	5125	11	1000
60	6600	11	1000	6600	11	1000

FRAG
TERRAIN

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(187-6)

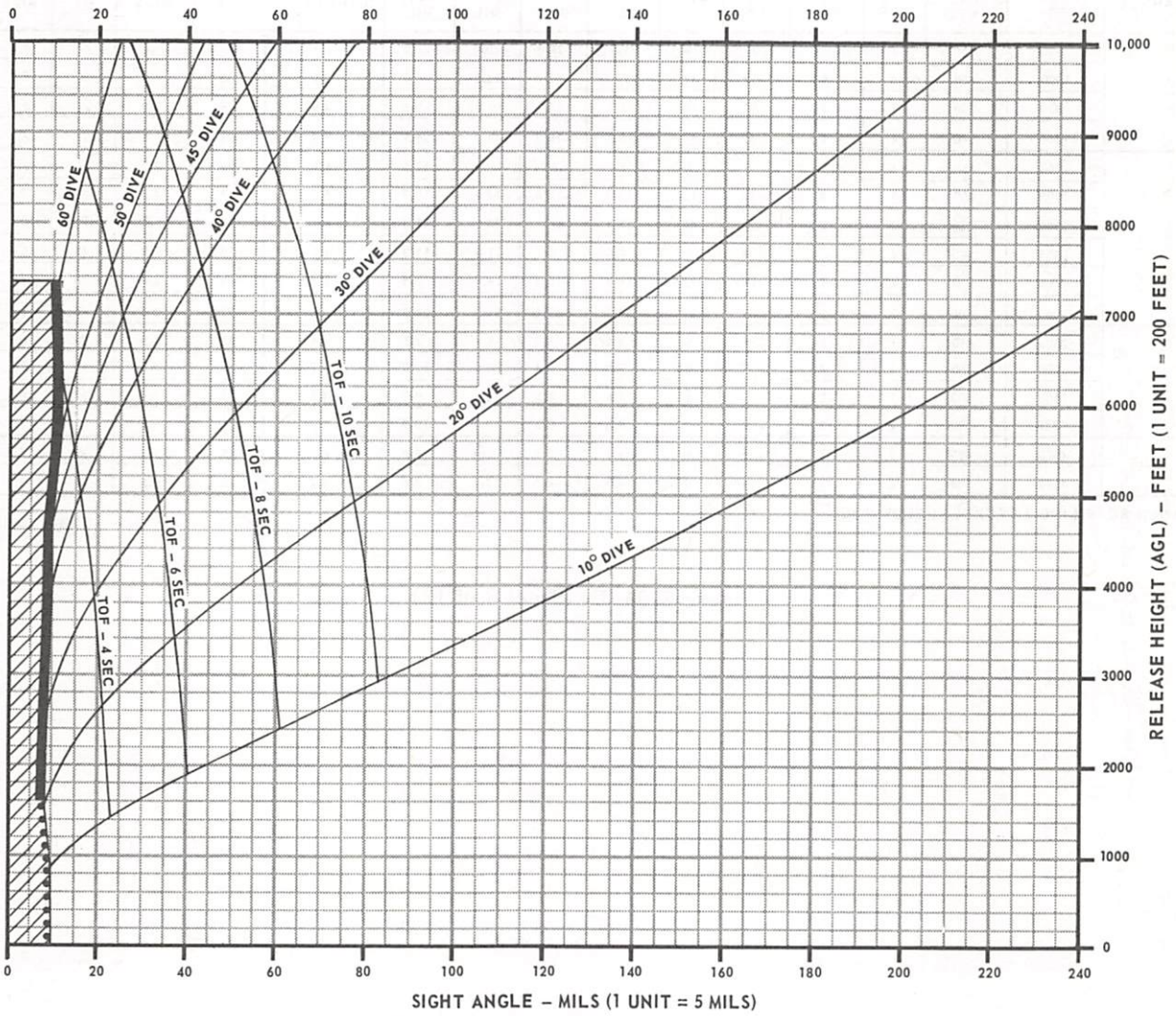
Figure 2-94 (U) (Sheet 6 of 12)

SIGHT ANGLE
MK 4 GUN POD
550 KTAS RELEASE

NEW

Notes

- GUN BORE LINE PARALLEL TO FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15-DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0-SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF – TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
	1.5 SEC BURST			3.0 SEC BURST		
	CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
10	850	10	450	900	11	500
20	1550	9	450	1550	9	450
30	2550	9	500	2550	9	500
40	3975	11	700	3975	11	700
45	4675	11	700	4675	11	700
50	5725	13	1000	5725	13	1000
60	7350	12	1000	7350	12	1000

FRAG
TERRAIN

NEW NEW NEW

0.000 HIT PROBABILITY TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(187-7)

Figure 2-94 (U) (Sheet 7 of 12)

RELEASE ERROR SENSITIVITIES & WIND CORRECTION

NEW NEW NEW NEW NEW NEW NEW

*MK 4 GUN POD

RELEASE PARAMETERS			ERROR SENSITIVITY (FT: +LONG, -SHORT)									RELATIVE WIND -10 KTS			
			AIRSPEED		HEIGHT		DIVE ANGLE		SIGHT ANGLE		ONE MIL LEFT OR RIGHT	RANGE		CROSS	
DIVE ANGLE (DEG)	HEIGHT (FT)	TAS (KTS)	+10 KTS	-10 KTS	+100 FT	-100 FT	+1 DEG	-1 DEG	+1 MIL	-1 MIL	SLANT RANGE 1000 FT	FT	MILS	FT	MILS
10°	800	450	3	-3	-34	24	15.6	-28.6	20.4	-21.5	4.1	26	1.2	26	6.2
	1000	450	4	-4	-55	39	30.9	-57.3	24.8	-26.0	5.0	36	1.4	36	7.1
	800	500	3	-3	-30	20	13.1	-24.1	19.6	-20.6	4.0	24	1.2	24	6.0
	1000	500	4	-4	-47	34	26.2	-48.3	23.9	-25.1	4.9	34	1.4	33	6.8
20°	1500	450	2	-1	- 9	7	5.3	- 6.9	11.2	-11.5	4.1	26	2.3	26	6.2
	2000	450	3	-3	-18	15	13.3	-18.8	14.7	-15.1	5.5	40	2.7	40	7.4
	3000	450	7	-7	-43	40	51.3	-68.1	20.5	-21.0	7.9	80	3.8	80	10.1
	1500	500	2	-2	- 8	7	4.6	- 6.3	11.0	-11.3	4.1	25	2.2	25	6.0
	2000	500	3	-3	-16	13	11.9	-16.4	14.4	-14.8	5.4	38	2.6	38	7.1
	3000	500	7	-7	-41	37	47.3	-63.1	20.2	-20.7	7.8	77	3.7	77	9.8
30°	2500	450	1	-1	- 5	5	4.0	- 5.0	9.1	- 9.3	4.8	32	3.5	32	6.7
	3000	450	2	-2	- 9	8	7.5	- 9.4	10.8	-11.0	5.7	43	3.9	43	7.5
	2500	500	1	-1	- 5	4	3.6	- 4.5	9.0	- 9.2	4.8	31	3.4	31	6.5
	3000	500	2	-2	- 8	7	6.8	- 8.5	10.7	-10.9	5.7	41	3.8	41	7.3
45°	4500	450	2	-2	- 4	4	4.2	- 5.0	8.4	- 8.5	6.2	48	5.7	48	7.8
	4500	500	2	-2	- 4	3	4.0	- 4.5	8.4	- 8.5	6.2	46	5.5	46	7.5

*GUN BORE LINE 2 DEGREES BELOW FRL

FDB-1T-(187-8)

UNCLASSIFIED

Figure 2-94 (U) (Sheet 8 of 12)

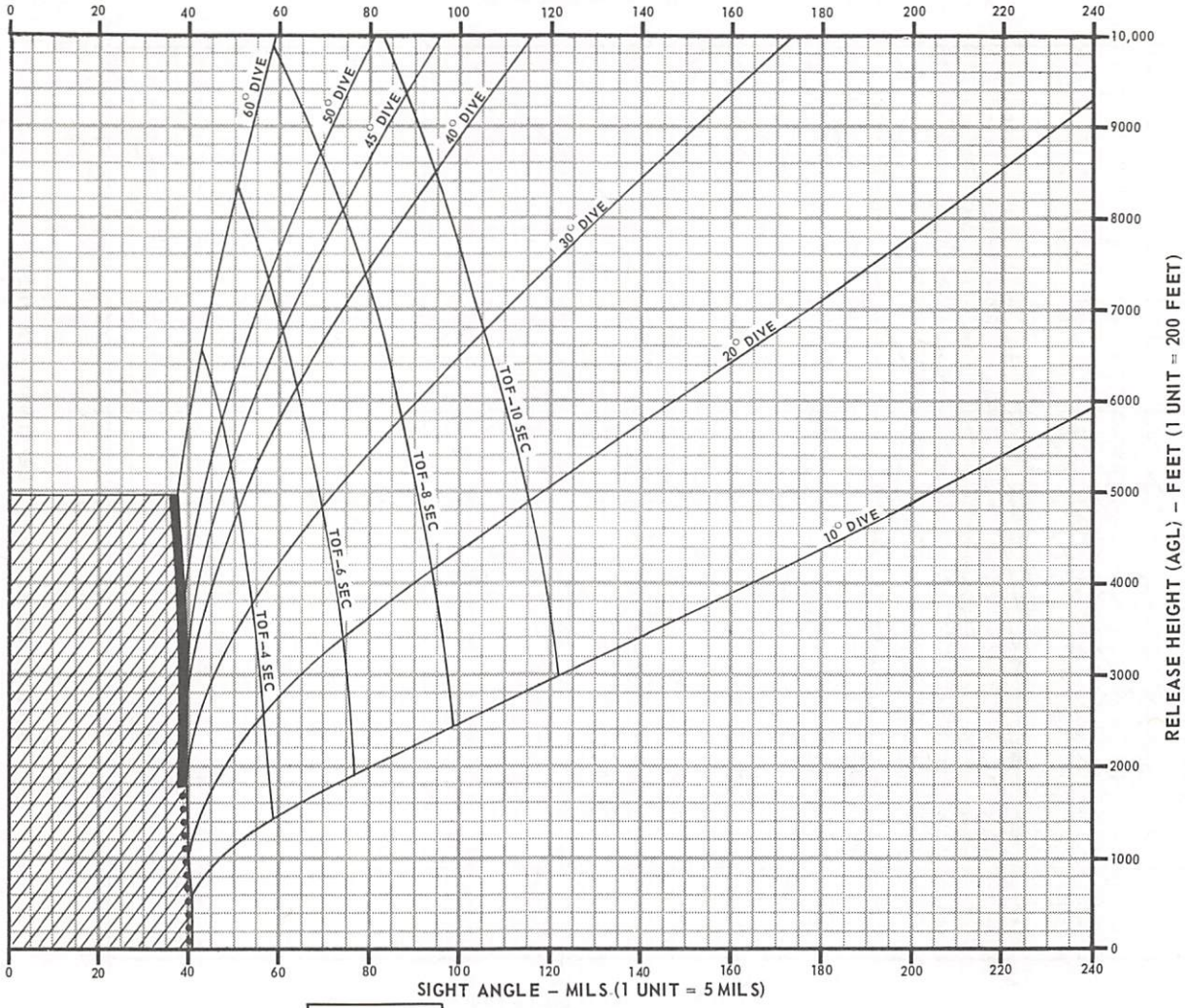
SIGHT ANGLE

MK 4 GUN POD

400 KTAS RELEASE

Notes

- GUN BORE LINE 2 DEGREES BELOW FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0–G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15 – DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0 – SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF – TIME OF FALL FROM RELEASE TO IMPACT – (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
	1.5 SEC BURST			3.0 SEC BURST		
	CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
10	600	41	325	600	41	325
20	1050	40	350	1100	40	400
FRAG / TERRAIN 30	1775	40	500	1775	40	500
40	2725	39	700	2725	39	700
45	3150	39	700	3150	39	700
50	3925	39	1000	3925	39	1000
60	4950	37	1000	4950	37	1000

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB–1T–(187–9)

Figure 2-94 (U) (Sheet 9 of 12)

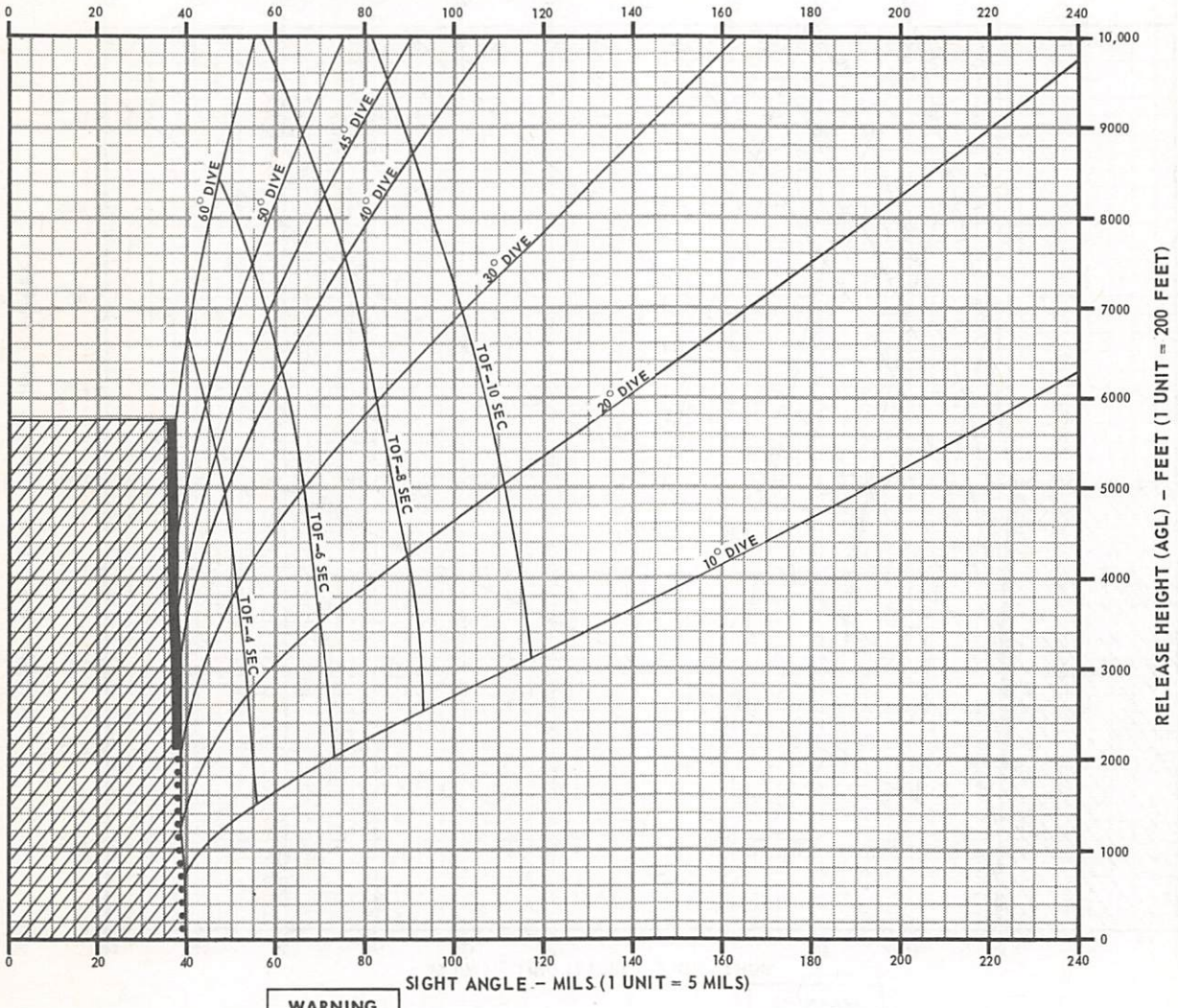
SIGHT ANGLE

MK 4 GUN POD

450 KTAS RELEASE

Notes

- GUN BORE LINE 2 DEGREES BELOW FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15 - DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0 - SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF - TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

	DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
		1.5 SEC BURST			3.0 SEC BURST		
		CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
FRAG	10	700	39	375	750	39	425
FRAG	20	1200	38	375	1250	38	425
TERRAIN	30	2025	38	500	2025	38	500
TERRAIN	40	3125	38	700	3125	38	700
TERRAIN	45	3650	38	700	3650	38	700
TERRAIN	50	4525	38	1000	4525	38	1000
TERRAIN	60	5750	37	1000	5750	37	1000

0.000 HIT PROBABILITY
TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(187-10)

Figure 2-94 (U) (Sheet 10 of 12)

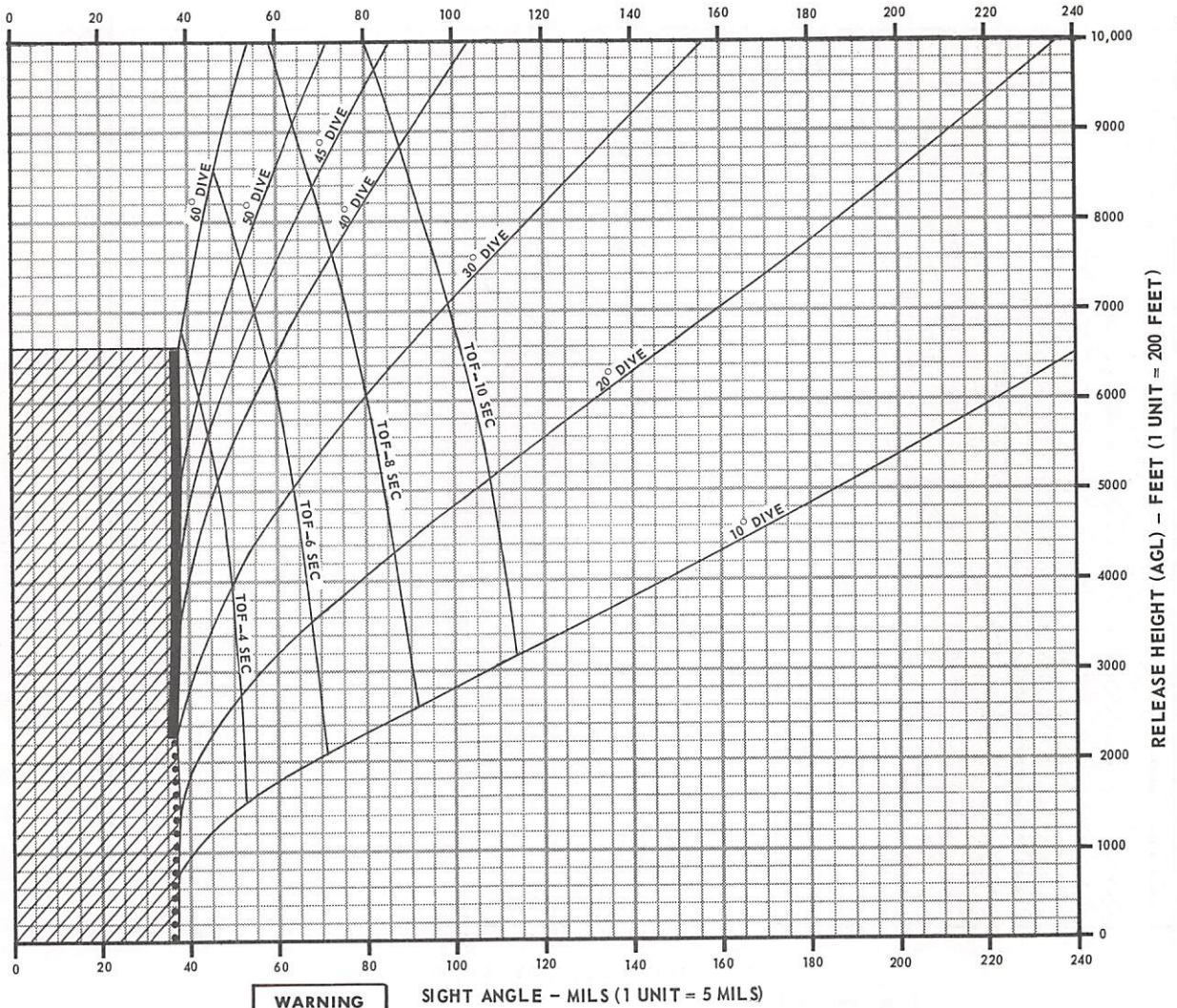
SIGHT ANGLE

MK 4 GUN POD

500 KTAS RELEASE

Notes

- GUN BORE LINE 2 DEGREES BELOW FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15 - DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0 - SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF - TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
	1.5 SEC BURST			3.0 SEC BURST		
	CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
10	750	37	400	850	38	500
20	1350	37	400	1400	37	450
FRAG / TERRAIN 30	2300	37	500	2300	37	500
40	3550	38	700	3550	38	700
45	4175	38	700	4175	38	700
50	5125	38	1000	5125	38	1000
60	6600	38	1000	6600	38	1000

0.000 HIT PROBABILITY TERRAIN AVOIDANCE

UNCLASSIFIED

FDB-1T-(187-11)

Figure 2-94 (U) (Sheet 11 of 12)

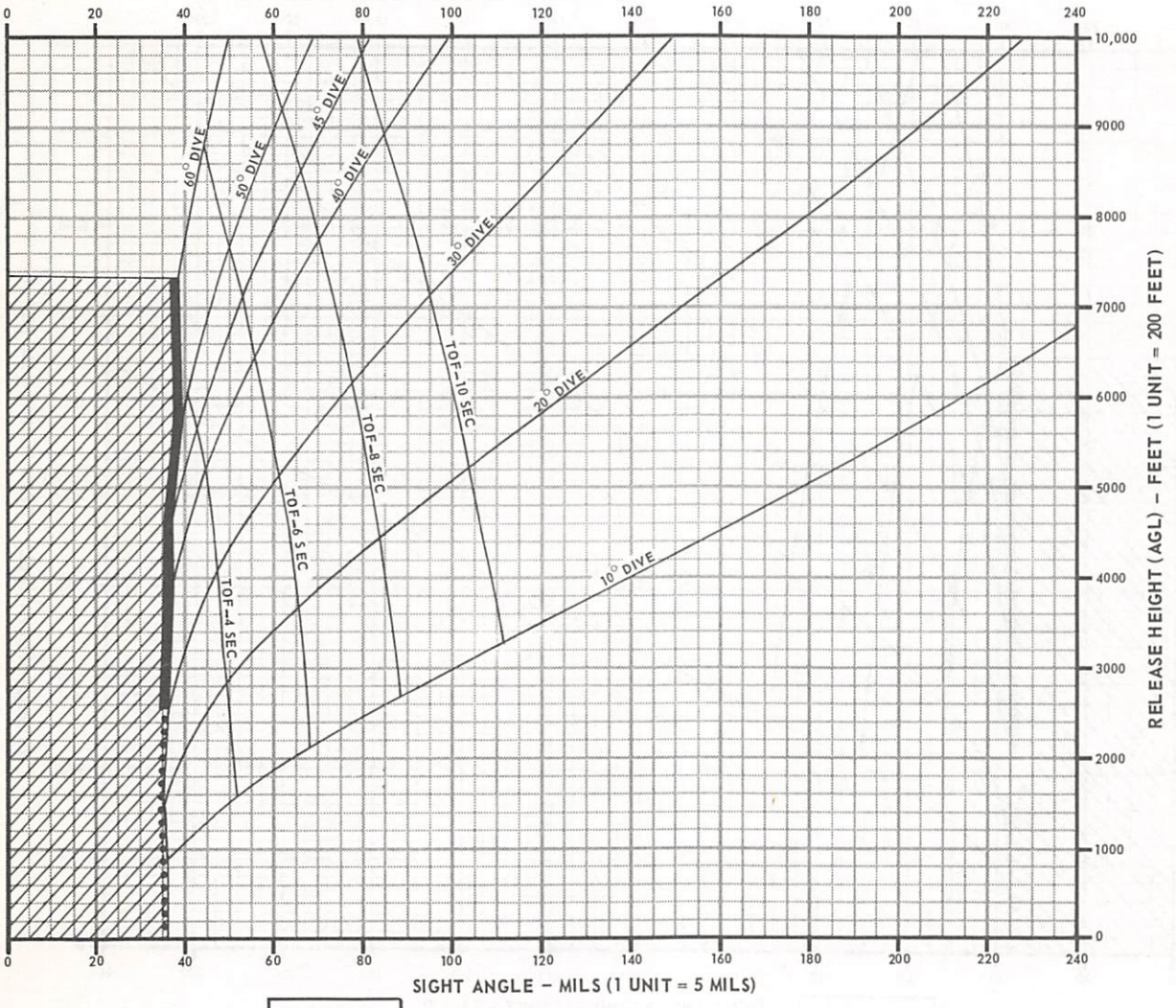
SIGHT ANGLE

MK 4 GUN POD

550 KTAS RELEASE

Notes

- GUN BORE LINE 2 DEGREES BELOW FRL
- SIGHT ANGLES ARE BASED ON 42,000 POUNDS AIRCRAFT GROSS WEIGHT, STANDARD DAY ATMOSPHERE, 0 FEET BURST ALTITUDE, 0 FEET TARGET ELEVATION, PARALLAX CORRECTION IS INCLUDED.
- CEASE FIRE HEIGHT FOR 20MM HEI FRAGMENT AND TERRAIN AVOIDANCE IS BASED ON A 4.0-G PULLUP RECOVERY INITIATED IMMEDIATELY AFTER CEASE FIRE TO ATTAIN A 15 - DEGREE CLIMBING ATTITUDE. AIRCRAFT/PILOT RESPONSE DELAY IS INCLUDED. THE 10° AND 20° DIVE CURVES TERMINATE AT THE 1.5 SECOND BURST FRAG ENVELOPE. 3.0 - SECOND FRAG DATA IS IN THE TABLE BELOW.
- TOF - TIME OF FALL FROM RELEASE TO IMPACT - (IN SECONDS).



WARNING

DIVE ANGLE (DEG)	0.000 HIT PROBABILITY (Height in Feet) AGL					
	1.5 SEC BURST			3.0 SEC BURST		
	CEASE FIRE	SIGHT ANGLE	RECOV-ERY	CEASE FIRE	SIGHT ANGLE	RECOV-ERY
10	900	36	500	950	37	550
20	1500	35	400	1500	35	400
FRAG / TERRAIN 30	2550	36	500	2550	36	500
40	3975	37	700	3975	37	700
45	4675	37	700	4675	37	700
50	5725	39	1000	5725	39	1000
60	7350	38	1000	7350	38	1000

0.000 HIT PROBABILITY TERRAIN AVOIDANCE

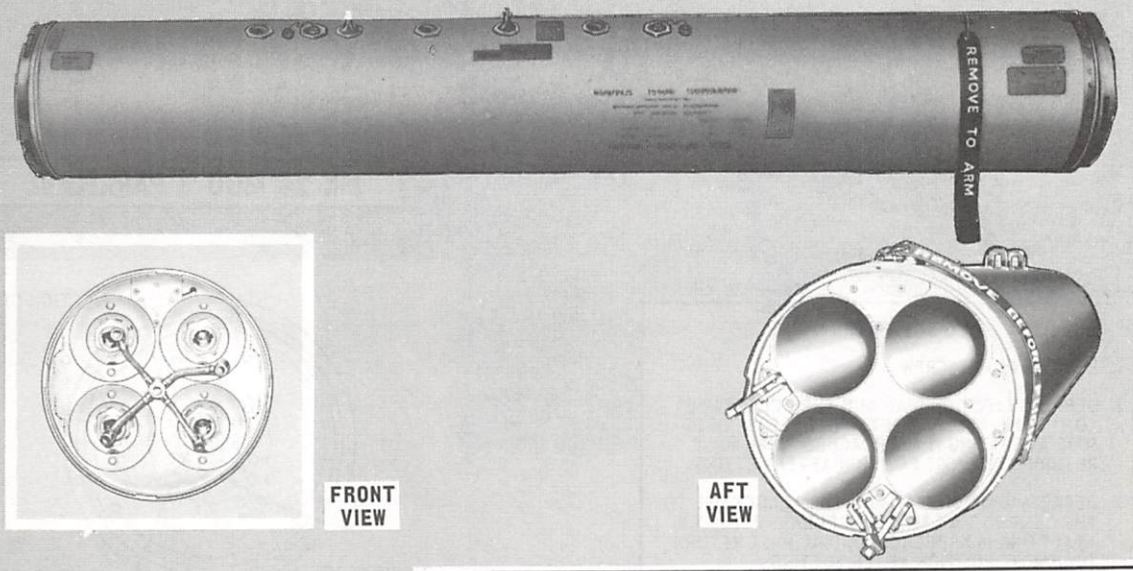
UNCLASSIFIED

FDB-1-T-(187-12)

Figure 2-94 (U) (Sheet 12 of 12)

SUU-40/A AND -44/A PARAFLARE DISPENSER

PARAFLARE & SENSOR DISPENSER



WEIGHT/EMPTY	132 POUNDS
WEIGHT/LOADED (MK 24 FLARES)	351 POUNDS
WEIGHT/LOADED (MK 45 FLARES)	359 POUNDS
LENGTH (W/O NOSE FAIRING)	96.0 INCHES
DIAMETER	13.9 INCHES
CAPACITY	8 FLARES
SINGLE FIRE	2 FLARES PER TUBE
SUSPENSION	14 OR 30 INCH

DESCRIPTION

The SUU-40/A and SUU-44/A paraflare dispensers have the capability of carrying and forcibly ejecting eight MK 24 MOD 4 or eight MK 45 MOD 0 parachute flares. Each of the four tubes of the unit can accomodate two paraflare assemblies. The paraflare assembly consists of a paraflare, drogue tray, and a paraflare actuation lanyard. Ejection force is provided by a MK 2 impulse cartridge installed in each breech. Detonation of the cartridge creates expanding gas in the ejector tube which exerts force against the forward paraflare assembly. This force moves both paraflare assemblies aft, causing the aft assembly to shear the paraflare retaining shear pin and allowing both paraflares to be ejected into the airstream. The force of the airstream separates the paraflare from the drogue tray. As the tray separates, the paraflare actuation lanyard, attached to the tray, pulls the safety cotter pin from the paraflare fuze and arms the paraflare. The SUU-44/A dispenser differs from the SUU-40/A in that the SUU-44/A is of original construction rather than a modified LAU-10.

WARNING

When cartridges are installed in the SUU-40/A and 44/A paraflare dispensers, remain clear of aft end of dispenser. Paraflare ejection forces are capable of propelling paraflare to a distance of 50 feet.

REFERENCES

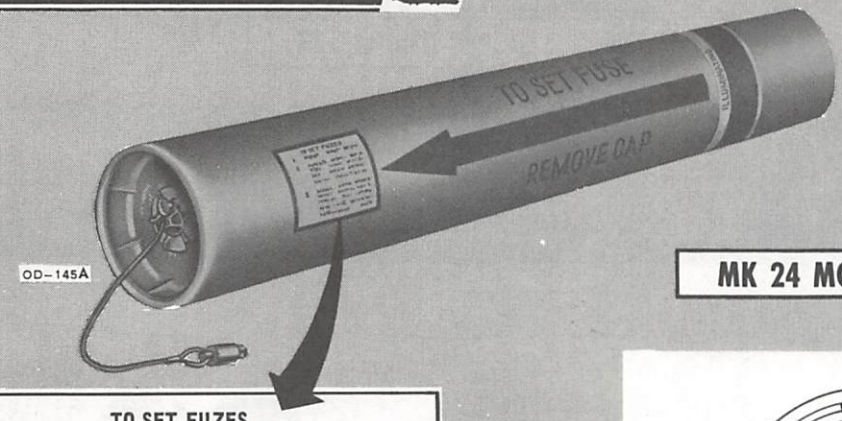
1. Paraflare Dispenser . . . . . NAVAIR 11-75AA-39
2. MK 24 Paraflares . . . . . NAVWEPS OP 2213
3. External Stores Limitations . . . . . APPENDIX A
4. CURRENT AAB's
5. Loading Procedures . . . . . NAVAIR 01-245FDB-75
6. Stores Reliability Cards . . . . . NAVAIR 01-245FD-75-8.2

UNCLASSIFIED

FDB-1T-(188)

Figure 2-95 (U)

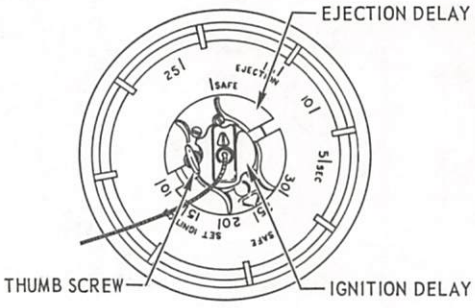
MK 24 PARAFLARE



TO SET FUZES

1. REMOVE THUMB SCREW.
2. DEPRESS EJECTION DIAL AND TURN CLOCKWISE TO THE DESIRED TIME SETTING, RELEASE PRESSURE AS SETTING IS APPROACHED. DIAL MUST RETURN TO UPMOST POSITION AFTER SETTING.
3. DEPRESS IGNITION DIAL AND TURN CLOCKWISE TO THE DESIRED TIME SETTING RELEASE PRESSURE. AS SETTING IS APPROACHED, DIAL MUST RETURN TO UPMOST POSITION AFTER SETTING.
4. POSITIVE STOP SAFETY PIN MUST BE ALLIED AS A FINAL OPERATION PRIOR TO FIRING.
5. IF PARAFLARE IS NOT FIRED, REPLACE SAFETY PIN.
6. TO RE-SET ON SAFE, DEPRESS AND TURN IN COUNTERCLOCKWISE DIRECTION TO SAFE.

MK 24 MOD 3 PARAFLARE



Length	36 INCHES
Diameter	4.8 INCHES
Weight	27 LBS

DESCRIPTION

The MK 24 Mod 3 and 4 aircraft parachute paraflare provides 2,000,000 candlepower illumination with a burn time of 180 seconds. Paraflare components include a cylindrical aluminum case, the candle, the parachute, and two variable mechanical time fuzes, an ejection fuze and an ignition fuze. The ejection fuze may be set for a delay of 5 to 30 seconds providing a freefall of 300 to 5000 feet. The parachute and candle are ejected from the cylindrical case when the ejection delay time elapses. The ejection delay permits the paraflare to decelerate prior to parachute opening thereby reducing the possibility of parachute failure. The ignition fuze may be set from 10 to 30 seconds permitting the suspended candle to descend an additional 150 to 450 feet before candle ignition. Delays are selected by positioning color coded dials on the fuze end of the paraflare.

When the MK 24 Mod 3 paraflare is released, a 12 pound pull on a steel lanyard initiates the ejection and ignition sequence which is controlled by the two mechanical time fuzes. When the force on the lanyard is approximately 50 pounds, a breakaway fitting severs, allowing the paraflare to fall free. When the MK 24 Mod 4 paraflare is ejected from the SUU-40/A & 44/A dispenser, the drogue tray provides the pulling force on the steel lanyard. Paraflare descent before parachute opening is approximately 300 feet the first 5 seconds, 700 feet during the next 5 seconds and 1000 feet for each 5 seconds thereafter. After parachute opening but prior to ignition, descent is approximately 15 feet per second; after paraflare ignition, descent is approximately 7.5 feet per second. This is general information. For planning, refer to sheet 3.

The MK 24 Mod 3 paraflare may be carried on the MER, TER, by adjusting the support bands for the appropriate suspension. The MK 24 Mod 4 paraflare (with Drogue Tray) is carried in the SUU-40/A and 44/A paraflare dispenser.

REFERENCES

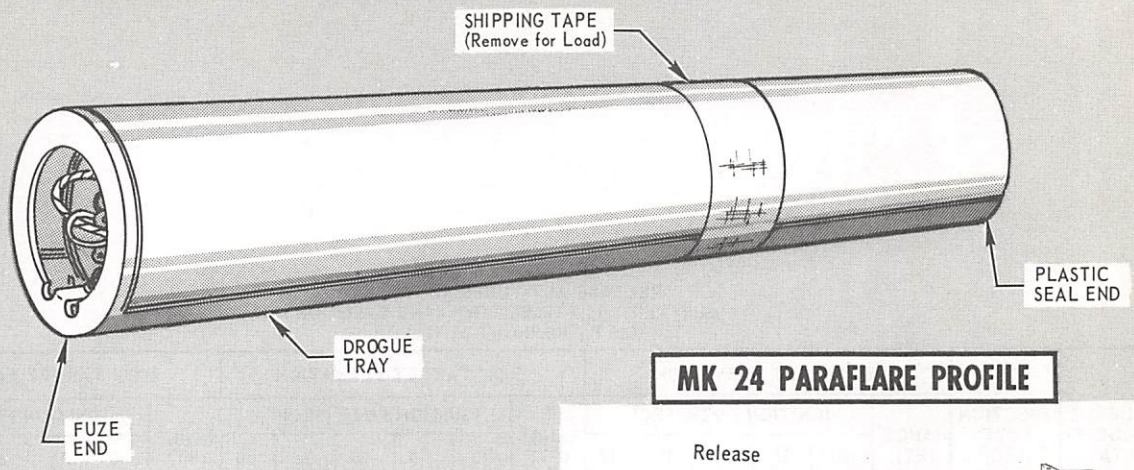
1. DESCRIPTION AND OPERATION . . . . . NAVWEPS OP 2213
2. BUILDUP AND LOADING PROCEDURES . . . . . AAB 347
3. LOADING PROCEDURES . . . . . NAVWEPS 01-245FDB-75
4. External Store Limitations . . . . . APPENDIX A
5. Current AAB's and AAC's
6. Stores Reliability Card . . . . . NAVAIR 01-245FD-75-8.1.

UNCLASSIFIED

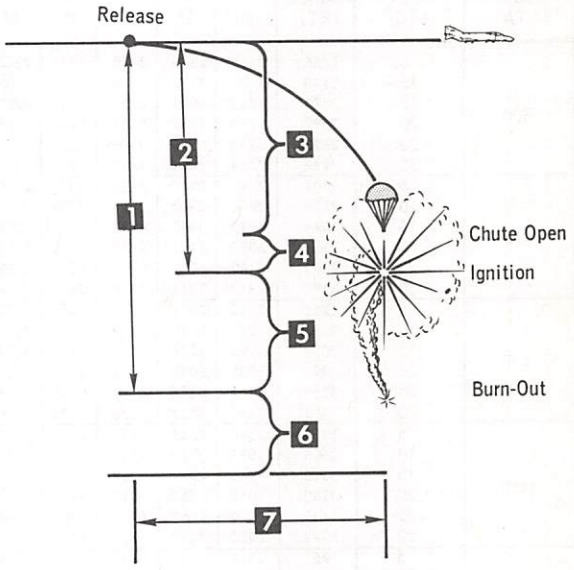
FDB-1T-(189-1)

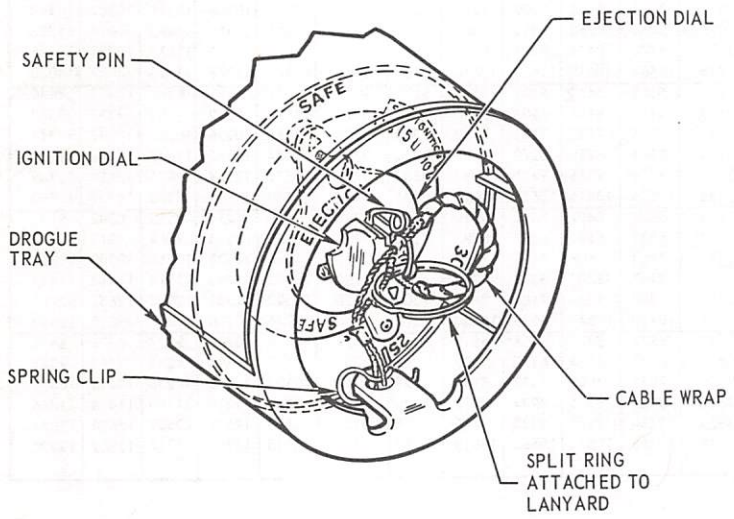
Figure 2-96 (U) (Sheet 1 of 4)

MK 24 PARAFLARE-CONTINUED



MK 24 PARAFLARE PROFILE





1. Minimum release altitude AGL required to provide paraflare burnout.
2. Vertical drop prior to paraflare ignition.
3. Ejection fuze delay time.
4. Ignition fuze delay time.
5. Paraflare Burning Time: 180 seconds.
6. Desired paraflare burnout height AGL.
7. Horizontal paraflare travel prior to ignition.

Note

MK 24 MOD 4 PARAFLARE CONFIGURED FOR SUU-40/A AND SUU-44/A

UNCLASSIFIED

FDB-1T-(189-2)

Figure 2-96 (U) (Sheet 2 of 4)

MK 24 MOD 3 AND 4 PARAFLARE DELIVERY DATA

RELEASE ALTITUDES ABOVE MSL
MER/TER – 15 FT/SEC DOWNWARD EJECTION
1000 FT BURNOUT ALTITUDE

RELEASE VELOCITY (KTAS)	EJECTION FUZE (SEC)	0' TARGET ELEVATION						3000' TARGET ELEVATION						6000' TARGET ELEVATION					
		RANGE (FT)	IGNITION FUZE (SEC)					RANGE (FT)	IGNITION FUZE (SEC)					RANGE (FT)	IGNITION FUZE (SEC)				
			10	15	20	25	30		10	15	20	25	30		10	15	20	25	30
300	5	1456	2350	2395	2440	2485	2530	1507	5404	5451	5497	5544	5591	1558	8460	8509	8558	8607	8656
	10	2110	3087	3133	3178	3223	3269	2211	6156	6203	6251	6298	6345	2316	9230	9280	9329	9379	9429
	15	2473	4045	4091	4137	4183	4229	2614	7147	7195	7243	7291	7339	2763	10253	10303	10354	10404	10455
	20	2690	5110	5157	5203	5249	5296	2862	8253	8302	8350	8399	8447	3044	11403	11454	11505	11556	11607
	25	2835	6215	6262	6309	6356	6403	3030	9413	9462	9511	9560	9610	3240	12617	12669	12721	12772	12824
	30	2946	7354	7401	7449	7497	7544	3160	10605	10655	10705	10754	10804	3393	13870	13923	13975	14027	14080
350	5	1601	2340	2385	2430	2475	2520	1661	5394	5441	5488	5535	5582	1722	8450	8499	8548	8597	8046
	10	2291	3063	3109	3154	3199	3245	2405	6132	6180	6227	6275	6322	2524	9204	9254	9303	9353	9403
	15	2674	4015	4061	4107	4153	4199	2832	7113	7161	7209	7258	7306	2998	10216	10266	10317	10367	10418
	20	2905	5075	5121	5168	5215	5261	3096	8214	8263	8312	8360	8409	3299	11361	11412	11463	11514	11565
	25	3061	6180	6227	6274	6321	6368	3277	9372	9421	9471	9520	9570	3509	12571	12623	12675	12726	12778
	30	3181	7314	7361	7409	7457	7504	3418	10560	10610	10660	10710	10760	3675	13820	13873	13925	13977	14030
400	5	1732	2335	2380	2425	2470	2515	1801	5385	5432	5479	5526	5573	1871	8442	8491	8541	8591	8640
	10	2451	3043	3089	3134	3179	3225	2578	6110	6158	6205	6253	6300	2711	9182	9232	9282	9332	9382
	15	2852	3990	4036	4082	4128	4174	3024	7085	7133	7181	7230	7278	3206	10185	10236	10286	10337	10388
	20	3094	5045	5091	5138	5185	5231	3301	8181	8230	8279	8327	8376	3523	11324	11375	11427	11478	11529
	25	3259	6147	6194	6241	6288	6335	3494	9336	9385	9435	9484	9534	3747	12532	12584	12636	12688	12740
	30	3388	7280	7327	7375	7423	7470	3645	10525	10575	10625	10675	10725	3924	13780	13833	13885	13937	13990
450	5	1852	2326	2371	2415	2460	2505	1929	5380	5427	5473	5519	5566	2008	8435	8484	8533	8582	8631
	10	2595	3027	3072	3118	3163	3208	2733	6093	6140	6187	6235	6282	2879	9165	9214	9264	9313	9363
	15	3010	3965	4011	4057	4103	4148	3195	7060	7108	7156	7204	7252	3392	10158	10208	10258	10308	10358
	20	3262	5017	5063	5110	5156	5203	3485	8152	8201	8249	8298	8346	3723	11293	11343	11394	11444	11494
	25	3435	6120	6167	6214	6261	6308	3687	9305	9354	9404	9453	9502	3958	12500	12551	12602	12652	12703
	30	3572	7250	7297	7345	7393	7440	3846	10490	10540	10590	10640	10690	4146	13745	13796	13847	13899	13950
500	5	1961	2320	2365	2410	2455	2500	2047	5372	5419	5466	5513	5560	2134	8430	8479	8527	8576	8625
	10	2725	3010	3055	3101	3146	3192	2875	6077	6124	6172	6219	6267	3031	9145	9194	9243	9293	9342
	15	3151	3945	3991	4037	4082	4128	3350	7037	7085	7133	7181	7229	3561	10135	10185	10235	10284	10334
	20	3413	4994	5040	5086	5133	5179	3650	8127	8175	8224	8272	8320	3903	11265	11315	11365	11416	11466
	25	3594	6095	6142	6188	6235	6281	3860	9280	9329	9378	9426	9475	4148	12468	12519	12569	12620	12671
	30	3737	7227	7274	7321	7368	7415	4028	10465	10514	10563	10613	10662	4346	13715	13766	13817	13869	13920

UNCLASSIFIED

FDB-1T-(189-3)

Figure 2-96 (U) (Sheet 3 of 4)

MK 24 MOD 3 AND 4 PARAFLARE DELIVERY DATA - CONTINUED

RELEASE ALTITUDES ABOVE MSL
SUU-40A/44A – 50 FT/SEC REARWARD EJECTION
1000 FT BURNOUT ALTITUDE

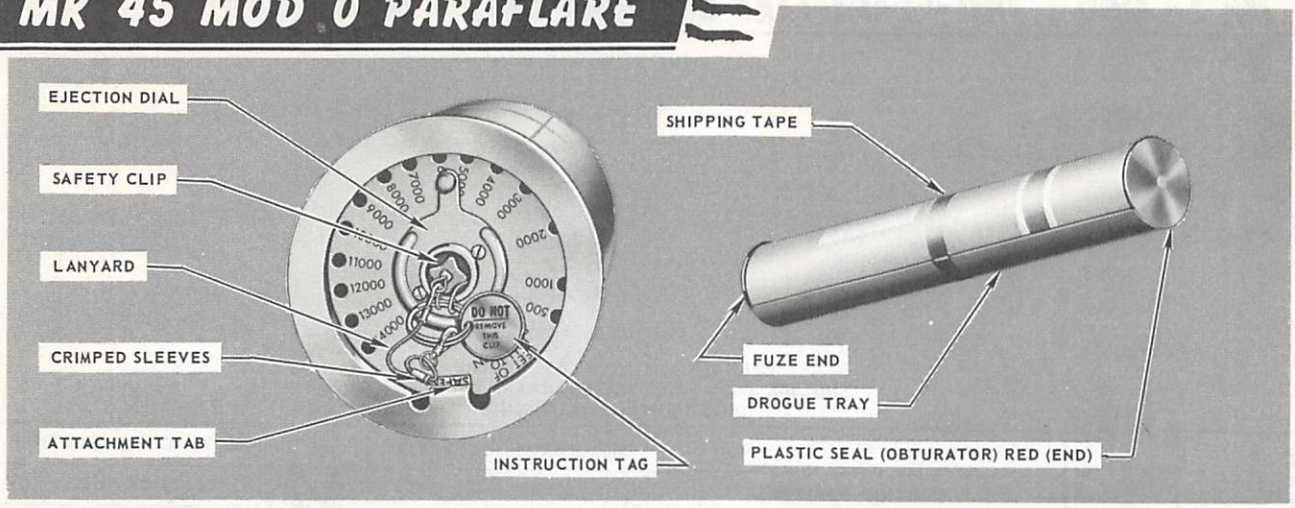
RELEASE VELOCITY (KTAS)	EJECTION FUZE (SEC)	0' TARGET ELEVATION						3000' TARGET ELEVATION						6000' TARGET ELEVATION					
		RANGE (FT)	IGNITION FUZE (SEC)					RANGE (FT)	IGNITION FUZE (SEC)					RANGE (FT)	IGNITION FUZE (SEC)				
			10	15	20	25	30		10	15	20	25	30		10	15	20	25	30
300	5	1364	2315	2360	2405	2449	2494	1410	5365	5412	5459	5505	5552	1455	8420	8469	8518	8567	8616
	10	1998	3042	3087	3133	3178	3224	2090	6108	6155	6203	6250	6297	2186	9180	9230	9279	9329	9379
	15	2351	4000	4046	4092	4138	4184	2481	7097	7145	7193	7241	7289	2618	10200	10250	10301	10351	10401
	20	2560	5060	5107	5153	5200	5247	2720	8201	8250	8298	8347	8395	2890	11352	11403	11454	11505	11556
	25	2699	6169	6216	6264	6311	6358	2881	9360	9409	9458	9507	9557	3077	12560	12612	12663	12715	12766
	30	2805	7302	7350	7398	7446	7494	3005	10552	10602	10652	10701	10751	3222	13813	13865	13918	13970	14022
350	5	1518	2307	2352	2397	2441	2486	1573	5358	5405	5452	5498	5545	1629	8412	8461	8510	8559	8608
	10	2192	3020	3065	3111	3156	3202	2298	6085	6132	6180	6227	6274	2409	9155	9205	9254	9304	9354
	15	2567	3971	4017	4063	4109	4155	2715	7064	7112	7160	7208	7255	2871	10166	10216	10267	10317	10367
	20	2792	5025	5072	5118	5165	5212	2972	8163	8211	8260	8308	8357	3164	11307	11358	11409	11460	11511
	25	2943	6132	6179	6227	6274	6321	3148	9320	9369	9418	9467	9516	3367	12516	12568	12619	12671	12722
	30	3059	7263	7311	7359	7407	7455	3283	10509	10559	10608	10658	10707	3527	13765	13817	13870	13922	13974
400	5	1657	2300	2345	2390	2434	2479	1721	5351	5398	5444	5491	5537	1786	8405	8454	8503	8551	8600
	10	2363	3000	3045	3091	3136	3182	2483	6066	6113	6160	6207	6255	2607	9135	9184	9234	9283	9333
	15	2757	3945	3991	4037	4083	4129	2920	7035	7083	7131	7178	7226	3093	10134	10184	10234	10284	10335
	20	2995	4997	5044	5090	5137	5184	3192	8130	8178	8227	8275	8324	3404	11272	11323	11374	11425	11475
	25	3156	6100	6147	6195	6242	6289	3379	9285	9334	9383	9432	9481	3621	12480	12532	12583	12635	12686
	30	3280	7230	7278	7326	7374	7422	3525	10472	10522	10572	10621	10671	3793	13724	13776	13829	13881	13933
450	5	1784	2293	2338	2383	2428	2473	1856	5345	5392	5438	5485	5531	1929	8399	8448	8497	8546	8595
	10	2515	2985	3031	3076	3122	3167	2647	6050	6097	6144	6191	6239	2785	9117	9167	9216	9266	9315
	15	2925	3922	3968	4014	4060	4106	3102	7013	7061	7109	7156	7204	3291	10109	10159	10209	10260	10310
	20	3173	4972	5019	5065	5112	5159	3387	8104	8152	8201	8249	8298	3616	11240	11291	11342	11392	11443
	25	3343	6074	6121	6168	6216	6263	3585	9256	9305	9354	9403	9452	3846	12446	12497	12549	12600	12652
	30	3475	7203	7251	7299	7346	7394	3740	10441	10491	10541	10590	10640	4028	13690	13742	13794	13846	13898
500	5	1899	2289	2334	2379	2423	2468	1979	5340	5387	5433	5480	5526	2061	8394	8443	8492	8541	8590
	10	2653	2972	3017	3063	3108	3153	2796	6035	6082	6129	6176	6223	2946	9100	9150	9199	9249	9298
	15	3075	3903	3949	3995	4041	4087	3266	6993	7041	7088	7136	7184	3469	10087	10137	10187	10238	10288
	20	3333	4950	4997	5043	5090	5136	3562	8080	8128	8177	8225	8273	3806	11215	11266	11317	11367	11418
	25	3510	6051	6098	6145	6192	6240	3768	9231	9280	9329	9378	9427	4047	12418	12469	12521	12572	12624
	30	3650	7179	7227	7275	7322	7370	3932	10415	10465	10514	10564	10613	4239	13660	13712	13764	13816	13868

UNCLASSIFIED

FDB-1T-(89-4)

Figure 2-96 (U) (Sheet 4 of 4)

MK 45 MOD 0 PARAFLARE



DESCRIPTION

The MK 45 paraflares provide about 3 minutes of illumination as they descend approximately 1300 feet. The MK45 MOD 0 paraflare incorporates the MK 364 MOD 0 fuze, to control the altitude of paraflare ejection in relation to launch altitude. It does not directly control candle ignition. The fuze has 15 functional settings and one safe setting. Functional settings may be made at 1000 foot intervals from 1000 to 14,000 feet. One minimum functional setting of 500 feet is also provided. Functional settings control the approximate altitude loss between flare launch and ejection of the candle and parachute assembly from the outer case. When the main parachute opens it exerts a pull on the cables of the suspension ignition system. The shorter of these cables pulls the release pin from the igniter assembly which in turn ignites the magnesium candle.

When the candle approaches the end of its burning time, the heat generated by final burnout activates an explosive bolt which severs 10 of the 18 parachute shroud lines allowing the parachute to collapse and flutter to the ground.

The following procedures are recommended for MK 45 paraflares.

1. Paraflare release altitude should be based on burnout at 1000 feet AGL or lower.
2. Paraflares should not interfere with attacking aircraft.
3. Run-in direction for paraflare drops should be made into the wind.

REMARKS:

1. Paraflare burning time . . . . . 180 sec.
2. Rate of fall . . . . . 15 fps suspended prior to ignition

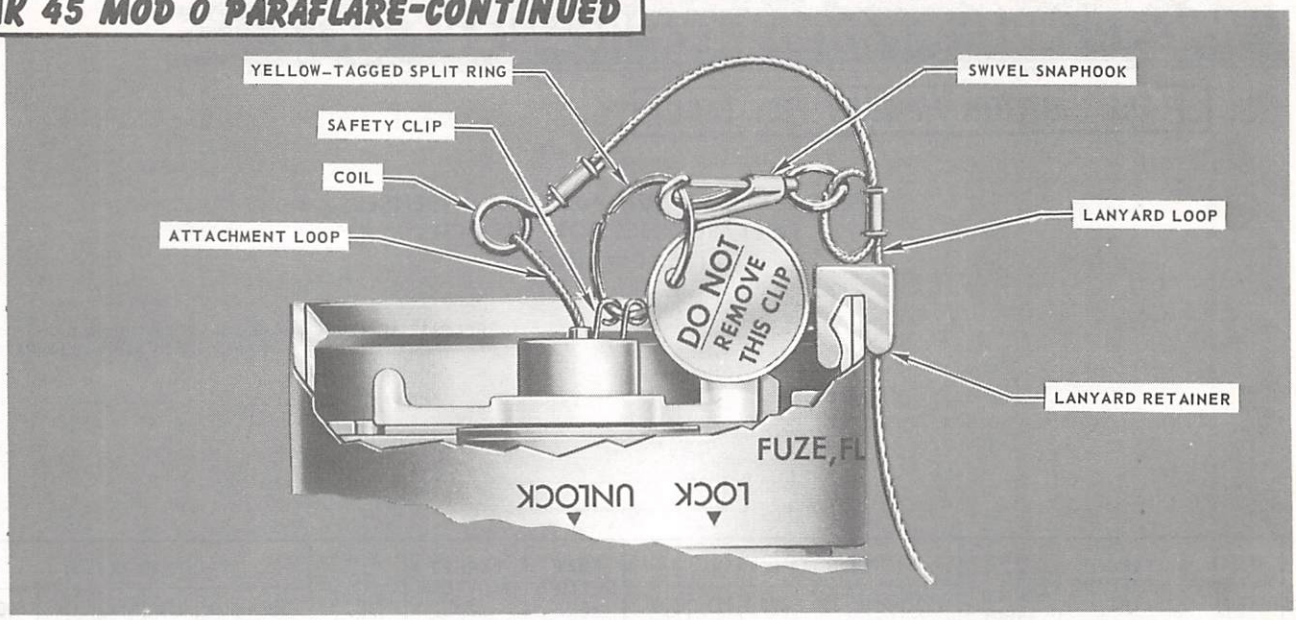
   7.5 fps after ignition
3. Paraflare reaches a terminal velocity of 200 fps after 12 to 13 seconds.
4. The paraflare will drift at 1.7 fps for each knot of wind.
5. The paraflare is 4.9 inches in diameter and 36 inches long.
6. Weight . . . . . 28 pounds

UNCLASSIFIED

FDB-1T-(190-1)

Figure 2-97 (U) (Sheet 1 of 4)

MK 45 MOD 0 PARAFLARE-CONTINUED



WARNING

The spring safety clip must not be removed from its position over the lanyard toggle. It is to be removed ONLY by lanyard action at the time of launching the paraflare. Under no circumstances shall the snaphook be attached to the split key ring except as the LAST STEP before aircraft take-off. In external carriage applications, this means after ALL other make-ready steps have been completed and the aircraft is fully ready for take-off.

MK 45 PARAFLARE FUZE SETTINGS

APPROXIMATE RELEASE ALTITUDES MSL FOR EJECTION AT 2500 FT. AGL
(ALTITUDES – IN THOUSANDS)

FUZE SETTING FOR EJECTION AT 2500 FT. ABOVE GROUND LEVEL. ↓

EXAMPLE:

FOR A TARGET AT 2000 FT. MSL, THE RELEASE ALTITUDE MSL MUST BE 5500 FT. WHEN THE FUZE SETTING IS 1000 TO PRODUCE PARAFLARE EJECTION AT 2500 FT. AGL.

	TARGET ELEVATION MSL							
	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
500	3.0	4.0	4.9	6.0	7.1	8.1	9.1	10.1
1,000	3.4	4.5	5.5	6.5	7.6	8.6	9.7	10.7
2,000	4.5	5.6	6.7	7.7	8.8	10.0	11.0	12.2
3,000	5.6	6.7	7.8	9.0	10.1	11.3	12.5	13.6
4,000	6.5	7.7	8.9	10.1	11.3	12.5	13.8	15.1
5,000	7.4	8.6	9.9	11.1	12.4	13.6	15.0	16.4
6,000	8.2	9.5	10.8	12.1	13.5	14.8	16.2	17.5
7,000	9.1	10.4	11.8	13.1	14.5	15.9	17.4	19.0
8,000	10.0	11.4	12.8	14.3	15.6	17.1	18.8	20.4
9,000	10.9	12.4	13.8	15.3	16.8	18.4	20.1	
10,000	11.8	13.3	14.9	16.4	18.1	19.8		
11,000	12.9	14.4	16.0	17.7	19.4			
12,000	13.9	15.5	17.3	19.0				
13,000	15.0	16.7	18.5	20.5				
14,000	16.2	18.0	20.0					

UNCLASSIFIED
FDB-1T-(190-2)

Figure 2-97 (U) (Sheet 2 of 4)

MK 45 MOD 0 PARAFLARE DELIVERY DATA

FLARE IGNITION AT 2500 FEET (AGL)

RELEASED FROM SUU-40A/44A DISPENSER
50 FT/SEC EJECTION VELOCITY
(REARWARD)

RELEASE ALTITUDE ABOVE MSL (FT) – UPPER FIGURE
RANGE (FT) – LOWER FIGURE

FUZE SETTING (FT)	TARGET ALTITUDE (FT)	TOF TO IGNITE (SEC)	VELOCITY (KTAS) 250	300	350	400	450	500
500	0	6.2	2955 1362	2945 1516	2936 1670	2926 1823	2917 1977	2907 2131
	3000	6.5	6006 1449	5995 1615	5984 1782	5973 1948	5962 2115	5951 2281
	6000	6.8	9057 1541	9045 1712	9032 1901	9020 2080	9007 2260	8995 2440
1000	0	9.3	3430 1713	3413 1887	3395 2061	3378 2235	3360 2409	3343 2583
	3000	9.8	6537 1833	6517 2022	6498 2211	6478 2401	6459 2590	6439 2779
	6000	10.4	9671 1969	9649 2176	9627 2383	9604 2589	9582 2796	9560 3003
2000	0	14.9	4502 2100	4476 2297	4449 2494	4423 2692	4396 2889	4370 3086
	3000	15.8	7750 2258	7720 2474	7690 2690	7659 2905	7629 3121	7599 3337
	6000	16.9	11061 2437	11027 2675	10993 2912	10958 3150	10924 3387	10890 3625
3000	0	19.8	5549 2293	5518 2504	5488 2714	5457 2925	5427 3135	5396 3346
	3000	21.2	8968 2476	8933 2708	8899 2940	8864 3172	8830 3404	8795 3636
	6000	22.8	12468 2681	12429 2938	12390 3195	12352 3452	12313 3709	12274 3966
4000	0	24.0	6483 2404	6450 2624	6417 2844	6385 3063	6352 3283	6319 3503
	3000	25.8	10047 2602	10011 2845	9975 3089	9938 3332	9902 3576	9866 3819
	6000	27.9	13736 2827	13695 3098	13653 3369	13612 3639	13570 3910	13529 4181
5000	0	27.9	7368 2484	7334 2711	7300 2938	7266 3166	7232 3393	7198 3620
	3000	30.0	11056 2694	11018 2946	10979 3199	10941 3451	10902 3704	10864 3956
	6000	32.7	14961 2940	14917 3223	14874 3506	14830 3788	14787 4071	14743 4354
6000	0	31.4	8175 2546	8140 2779	8105 3012	8070 3246	8035 3479	8000 3712
	3000	34.0	12034 2771	11994 3032	11954 3292	11915 3553	11875 3813	11835 4074
	6000	37.0	16081 3031	16036 3324	15990 3618	15945 3911	15899 4205	15854 4498

FUZE SETTING (FT)	TARGET ALTITUDE (FT)	TOF TO IGNITE (SEC)	VELOCITY (KTAS) 250	300	350	400	450	500
7000	0	35.0	9016 2603	8980 2843	8945 30a3	8909 3322	8874 3562	8838 3802
	3000	38.0	13028 2843	12987 3112	12946 3381	12905 3650	12864 3919	12823 4188
	6000	41.6	17300 3125	17253 3430	17206 3735	17159 4040	17112 4345	17065 4650
8000	0	38.7	9893 2660	9856 2906	9819 3152	9783 3399	9746 3645	9709 3891
	3000	42.1	14065 2915	14022 3193	13980 3470	13937 3748	13895 4025	13852 4303
	6000	46.4	18600 3223	18551 3540	18502 3858	18453 4175	18404 4493	18355 4810
9000	0	42.5	10805 2718	10767 2971	10729 3224	10691 3476	10653 3729	10615 3982
	3000	46.4	15167 2990	15124 3277	15080 3564	15037 3851	14993 4138	14950 4425
	6000	51.4	19990 3328	19938 3659	19886 3990	19834 4321	19782 4652	19730 4983
10,000	0	46.4	11756 2777	11717 3037	11678 3297	11638 3557	11599 3817	11560 4077
	3000	50.8	16318 3069	16272 3366	16227 3663	16181 3960	16136 4257	16090 4554
	6000							
11,000	0	50.4	12748 2839	12707 3107	12667 3375	12626 3643	12586 3911	12545 4178
	3000	55.4	17545 3155	17497 3463	17449 3771	17401 4079	17353 4387	17305 4695
	6000							
12,000	0	54.5	13778 2905	13736 3181	13694 3457	13652 3732	13610 4008	13568 4284
	3000	60.3	18879 3251	18829 3571	18779 3892	18730 4212	18680 4533	18630 4853
	6000							
13,000	0	58.8	14879 2976	14835 3261	14791 3546	14748 3830	14704 4115	14660 4400
	3000	65.3	20272 3354	20220 3688	20167 4022	20115 4356	20062 4690	20010 5024
	6000							
14,000	0	63.1	15998 3051	15953 3345	15907 3639	15862 3934	15816 4228	15771 4522
	3000							
	6000							

UNCLASSIFIED

FDB-1T-(190-3)

Figure 2-97 (U) (Sheet 3 of 4)

MK 45 MOD 0 PARAFLARE DELIVERY DATA-CONTINUED

FLARE IGNITION AT 2500 FEET (AGL)

RELEASED FROM MER/TER 15 FPS
DOWNWARD EJECTION VELOCITY

RELEASE ALTITUDE ABOVE MSL (FT) – UPPER FIGURE
RANGE (FT) – LOWER FIGURE

FUZE SETTING (FT)	TARGET ALTITUDE (FT)	TOF TO IGNITE (SEC)	VELOCITY (KTAS) 250	300	350	400	450	500
500	0	6.2	3000 1474	2988 1619	2977 1764	2965 1909	2954 2054	2942 2199
	3000	6.5	6053 1571	6040 1728	6028 1884	6015 2041	6003 2197	5990 2354
	6000	6.8	9105 1672	9091 1842	9078 2011	9064 2181	9051 2350	9037 2520
1000	0	9.3	3478 1841	3459 2004	3440 2167	3420 2330	3401 2493	3382 2656
	3000	9.8	6587 1972	6566 2149	6545 2327	6523 2504	6502 2682	6481 2859
	6000	10.4	9723 2121	9700 2315	9676 2508	9653 2702	9629 2895	9606 3089
2000	0	14.9	4551 2245	4523 2429	4495 2613	4467 2796	4439 2980	4411 3164
	3000	15.8	7801 2416	7770 2617	7739 2819	7707 3020	7676 3222	7645 3423
	6000	16.9	11115 2611	11080 2833	11045 3055	11010 3276	10975 3498	10940 3720
3000	0	19.8	5599 2447	5567 2643	5535 2839	5504 3036	5472 3232	5440 3428
	3000	21.2	9020 2645	8984 2861	8949 3078	8913 3294	8878 3511	8842 3727
	6000	22.8	12522 2868	12483 3108	12443 3348	12404 3587	12364 3827	12325 4067
4000	0	24.0	6533 2565	6500 2769	6466 2974	6433 3178	6399 3383	6366 3587
	3000	25.8	10099 2780	10062 3006	10025 3233	9988 3459	9951 3686	9914 3912
	6000	27.9	13790 3024	13748 3276	13706 3529	13665 3781	13623 4034	13581 4286
5000	0	27.9	7418 2650	7384 2861	7349 3073	7315 3284	7280 3496	7246 3707
	3000	30.0	11109 2878	11070 3113	11031 3348	10991 3583	10952 3818	10913 4053
	6000	32.7	15017 3146	14973 3410	14929 3673	14884 3937	14840 4200	14796 4464
6000	0	31.4	8226 2716	8190 2933	8155 3150	8119 3368	8084 3585	8048 3802
	3000	34.0	12088 2960	12047 3203	12007 3446	11966 3688	11926 3931	11885 4174
	6000	37.0	16138 3244	16092 3518	16046 3791	16000 4065	15954 4338	15908 4612

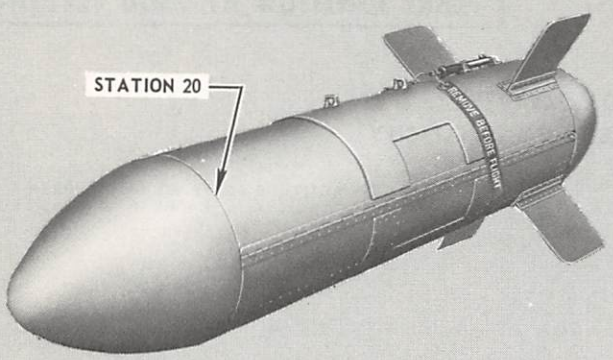
FUZE SETTING (FT)	TARGET ALTITUDE (FT)	TOF TO IGNITE (SEC)	VELOCITY (KTAS) 250	300	350	400	450	500
7000	0	35.0	9067 2778	9030 3001	8994 3224	8957 3447	8921 3670	8884 3893
	3000	38.0	13083 3038	13041 3289	12999 3539	12957 3790	12915 4040	12873 4291
	6000	41.6	17360 3346	17312 3630	17264 3915	17216 4199	17168 4484	17120 4768
8000	0	38.7	9944 2840	9907 3069	9869 3298	9832 3527	9794 3756	9757 3985
	3000	42.1	14120 3117	14077 3376	14034 3634	13990 3893	13947 4151	13904 4410
	6000	46.4	18663 3454	18613 3750	18563 4046	18513 4341	18463 4637	18413 4933
9000	0	42.5	10857 2902	10819 3137	10780 3373	10742 3608	10703 3844	10665 4079
	3000	46.4	15224 3199	15179 3466	15134 3734	15090 4001	15045 4269	15000 4536
	6000	51.4	20051 3569	19999 3877	19946 4186	19894 4494	19841 4803	19789 5111
10,000	0	46.4	11811 2966	11771 3208	11731 3451	11691 3693	11651 3936	11611 4178
	3000	50.8	16375 3285	16328 3562	16282 3839	16235 4115	16189 4392	16142 4669
	6000							
11,000	0	50.4	12801 3034	12760 3283	12719 3533	12677 3782	12636 4032	12595 4281
	3000	55.4	17603 3379	17555 3666	17507 3953	17458 4240	17410 4527	17362 4814
	6000							
12,000	0	54.5	13833 3105	13790 3362	13748 3619	13705 3876	13663 4133	13620 4390
	3000	60.3	18938 3483	18887 3782	18837 4081	18786 4380	18736 4679	18685 4978
	6000							
13,000	0	58.8	14932 3183	14888 3448	14844 3714	14801 3979	14757 4245	14713 4510
	3000	65.3	20333 3596	20280 3908	20227 4219	20175 4531	20122 4842	20069 5154
	6000							
14,000	0	63.1	16054 3265	16008 3539	15962 3813	15917 4088	15871 4362	15825 4636
	3000							
	6000							

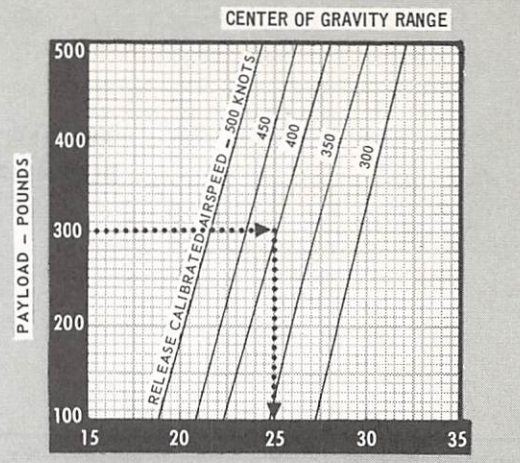
UNCLASSIFIED

FDB-1T-(190-4)

Figure 2-97 (U) (Sheet 4 of 4)

CTU-1/A DELIVERY CONTAINER





Note

THE ALLOWABLE CENTER OF GRAVITY RANGE INCLUDES ALL POSITIONS FORWARD OF THE AFT LIMIT

CHARACTERISTICS	
WEIGHT; EMPTY	230 POUNDS
LOADED	MAXIMUM 500 POUNDS
LENGTH	104 INCHES
DIAMETER	21 INCHES
CARGO SPACE	10.5 CUBIC FEET
LOADING PROCEDURES	NAVAIR 01-245FDB-75
STORES RELIABILITY CARD	NAVAIR 01-245FD-75-15.1

DESCRIPTION

The CTU-1/A is a parachute retarded container used to deliver combat supplies to ground forces. The container may be loaded with any equipment up to a maximum weight of 500 pounds., provided the equipment can be loaded to maintain the container C.G. within allowable limits. (See Center of Gravity Range chart.)

Note

The parachute system limits the delivery altitude to 300 feet AGL minimum. Refer to External Stores Limitations, Appendix I. The down range travel varies from 1500 to 2000 feet.

The CTU-1/A consists of three basic assemblies: the fin stabilized container, an XM5 cartridge-actuated parachute release assembly, and the parachute assembly. At release, the initiator cable attached to the rack causes detonation of the cartridge-actuated release assembly. After a 0.3 second delay, the release assembly ejects the tail cone and deploys the pilot parachute. The pilot parachute in turn deploys the main parachute to a reefed diameter of 36 inches. Explosive cutters then part a reefing line and initiate blossoming to full diameter. Container descent is therefore controlled to an impact velocity of approximately 30 feet per second and at a nearly vertical impact angle.

At release, the aerodynamic stability of the loaded container is specifically dependent on maintaining the loaded container center of gravity within specified limits. Improper C.G. control can result in violently unstable separation characteristics. The appropriate authority must therefore verify that the weight and C.G. location are within allowable limits as a function of the planned payload and release airspeed.

The Center of Gravity chart is provided to establish a limit CTU-1/A C.G. to verify container stability at release. The chart locates the most aft allowable C.G. position as a function of container payload weight and release calibrated airspeed. The measurement is expressed as the distance between the leading edge of the center section (station 20) and the most aft center of gravity. The allowable C.G. therefore includes any point forward of the aft limit. Enter the chart with the planned payload weight, project to the planned release calibrated airspeed, and down to read the aft limit. The actual C.G. must be forward of this point.

CAUTION

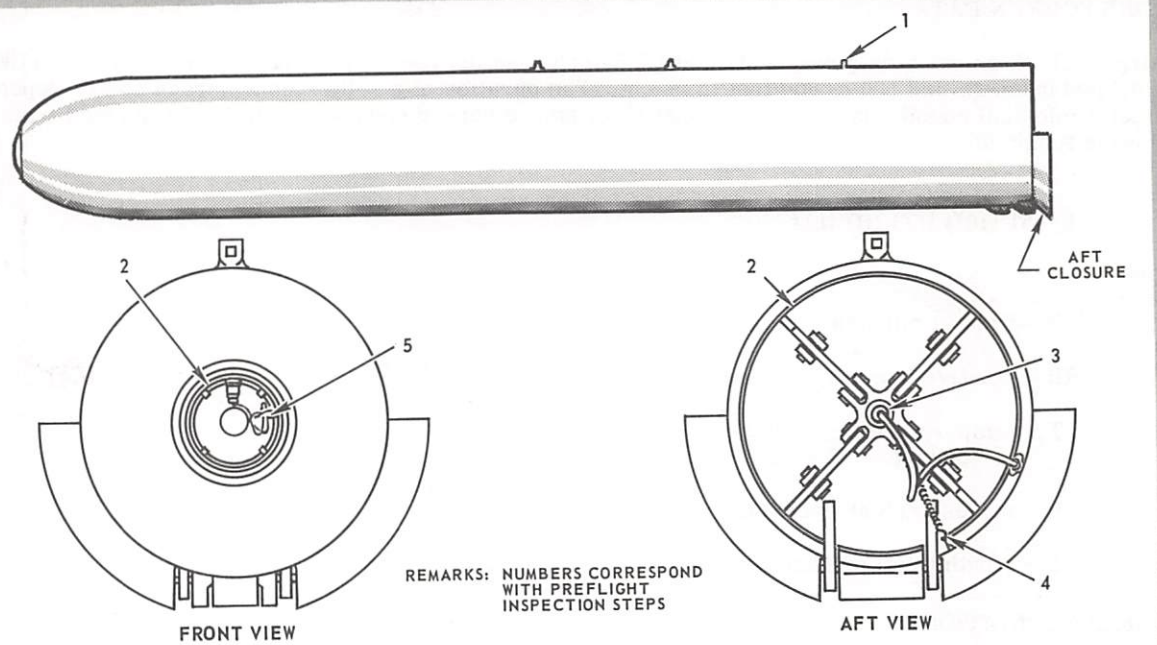
If the actual C.G. is aft of the chart measurement, then the release speed and/or payload weight must be adjusted to establish an acceptable C.G. position. Failure to observe the required C.G. limits can result in unstable separation characteristics.

UNCLASSIFIED

FDB-1T-(193)

Figure 2-98 (U)

MK 12 MOD 0 SMOKE TANK



CHARACTERISTICS:

Length	9 FEET, 1 INCH
Diameter	14 INCHES
Weight (Empty)	340 LBS
(Full)	1000 LBS
Capacity	500 SMOKE CONTAINERS

DESCRIPTION

The MK 12 MOD 0 smoke tank is used to disseminate free liquid smoke agent (55 percent sulphur trioxide and 45 percent chlorosulphuric acid) and perforated aluminum spheres containing smoke agent. The aircraft electrical system provides power to fire the explosive bolt in the aft closure section, blowing open the hinged steel plate. As the hinged steel plate opens, circuitry is completed allowing the 28 vdc to fire the nose section detonator, breaking the clear plastic seal. Ram air entering through the nose inlet disseminates the liquid smoke agent and the aluminum spheres containing smoke agent. The tank contains approximately 500 aluminum spheres, 2 3/4 inches in diameter. Half of the spheres are pierced with 1/2-inch diameter hole; the remainder are pierced with 1/8-inch diameter holes. The liquid smoke agent reacts with the moisture in the air, forming sulphuric and hydrochloric acid droplets. These droplets refract and scatter light to form the smoke screen. The smoke screen consists of three overlapping strata. The upper stratum is formed by the free liquid smoke agent, which surrounds the aluminum spheres within the tank. The second stratum is formed by smoke agent escaping from the aluminum spheres with the 1/2 inch diameter holes. The lower stratum is formed by smoke agent escaping from the aluminum spheres with the 1/8-inch holes and from the spheres that break open at ground impact. These three strata move together in approximately 30 to 60 seconds to form a solid smoke screen.

Smoke screen operations can effectively be used in the following type missions:

a. Close air support
b. Beach landings
c. Mine laying operations
d. Covering friendly shore bombardment ships.

Smoke screen operations near friendly troops must be conducted under the coordination of a forward air controller. Retirement should be away from friendly forces if no hostile fire is expected. If ground fire is expected, a turn into friendly forces is justified.

CONFIDENTIAL

FDB-1T-(194-1)

Figure 2-99 (C) (Sheet 1 of 3)

MK 12 MOD 0 SMOKE TANK-CONTINUED

SMOKE SCREEN DATA

A single MK 12 smoke tank (using a standard 2.5-inch nose orifice) can produce a smoke screen 1100 (± 200) feet in length and 500 to 800 feet in height. The duration of a solid smoke screen varies depending on meteorological conditions. An approximation of smoke screen endurance can be determined from the following formula:

$$t = 51\ (10^6) \left(\frac{RH}{(T)\ (H)\ (L)} \right)$$

Where:

t = time in minutes

RH = relative humidity in percent

T = temperature in °Rankine
(°Rankine = °F + 460°)

H = release height (feet) AGL

L = length (feet) of smoke screen

RELEASE CONDITIONS

The smoke dissemination maneuver consists of a level pass, flown below 300 feet AGL at 450 KTAS. The lower the release altitude, the thicker the smoke screen produced. The maneuver may be entered from either level flight or a shallow dive. When dissemination is complete, appropriate evasive action should be taken.

DUAL TANK OPERATIONS

Dual tank operations consist of employing a second tank either to reseed the screen produced by the first tank or to form an elongated smoke screen. Reseeding will require a second pass, whereas the use of the second tank to elongate the screen is accomplished by tandem dissemination of two tanks on a single pass using an approximate 2-second firing delay for the second tank.

SECTION TACTICS

Multiple aircraft tactics increase the smoke screen capability over that obtained by a single aircraft. Smoke from the additional aircraft either augments the screen produced by using parallel disseminations, or extends the length by tandem dissemination. Parallel dissemination from more than one aircraft results in increased width and opaqueness of the screen, and , with 4 knots of wind or less, prolongs the duration of an effective screen. Wind in excess of 5 knots reduces smoke screen duration by causing the screen to break up and move out of the target area.

WARNING

Carefully consider wind direction and velocity when disseminating the smoke agent in close proximity to friendly forces. The smoke agent is a strong irritant to skin and inhalation of fumes causes choking.

For section dissemination, the wingman should fly a free cruise position with an abeam distance of from 50 to 75 feet.

CONFIDENTIAL

FDB-1T-(194-2)

Figure 2-99 (C) (Sheet 2 of 3)

MK 12 MOD 0 SMOKE TANK-CONTINUED

CAUTION

Wingmen should not lag behind lead aircraft during smoke dissemination maneuver. The smoke agent and aluminum spheres from the lead aircraft diverge widely upon release and could create a collision hazard or subsequent corrosion. If the smoke agent comes into direct contact with aircraft, the aircraft must be decontaminated.

PREFLIGHT

1. Umbilical cord from rack to tank . . . . . DISCONNECT

Note

The umbilical cord is connected after aircraft is started and stray voltage check has been completed.

2. No leakage of smoke agent from aft closure section or nose air inlet seal.

3. Explosive bolt installed in aft enclosure section.

4. Steel spring attached from explosive bolt to hinge area of aft enclosure section.

5. Nose air inlet seal detonator installed (electrical lead wires connected to center section of clear plastic cover).

OPERATION CONSIDERATIONS

CAUTION

When only one tank is fired, considerable aircraft yawing will occur.

JETTISON CONSIDERATIONS

If an attempt has been made to fire the smoke tank and the tank malfunctions (smoke discharging from the nose and not the tail, or smoke discharging from the tail in an erratic pattern or an extremely long trail), jettison the tank by means of the emergency stores jettison method.

WARNING

Arrested landings are not permitted with a full smoke tank. In case of an aborted mission, empty tank by normal procedures or jettison tank over a safe area prior to an arrested landing. Flared field landings are permitted with the full smoke tank if no attempt has been made to fire.

REFERENCES

1. Aircraft Chemical Tank . . . . . NAVAIR 11-45-605
2. External Store Limitations . . . . . .Appendix I
3. Fuzing and Fuze Limitations . . . . . .Section II, Part 1
4. Loading Procedures, Arming Wire Configuration, and Suspension Equipment . . . . . NAVAIR 01-245FDB-75
5. Current AAB's.

CONFIDENTIAL

FDB-1T-(194-3)

Figure 2-99 (C) (Sheet 3 of 3)

CONLABS PULLUP-TO-IMPACT DISTANCE

J79-GE-8 ENGINES			MK 76 MOD 5 PRACTICE BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			12447	15279	16460	14721	18133	19780
LAST BOMB – FEET	3 BOMBS	60 MSEC	12775	15462	16417	15071	18337	19752
		100 MSEC	12986	15576	16381	15298	18465	19725
		140 MSEC	13192	15684	16338	15520	18588	19692
	4 BOMBS	60 MSEC	12934	15548	16391	15242	18434	19733
		100 MSEC	13242	15710	16327	15574	18618	19682
		140 MSEC	13537	15857	16249	15894	18789	19616
	6 BOMBS	60 MSEC	13242	15710	16326	15574	18618	19682
		100 MSEC	13727	15947	16189	16101	18896	19564
		140 MSEC	14175	16143	16014	16595	19138	19403
	8 BOMBS	60 MSEC	13538	15857	16248	15895	18789	19617
		100 MSEC	14175	16143	16014	16595	19138	19403
		140 MSEC	14740	16348	15709	17230	19415	19104
	12 BOMBS	60 MSEC	14089	16108	16050	16500	19093	19439
		100 MSEC	14960	16411	15557	17483	19512	18949
		140 MSEC	15645	16507	14908	18299	19746	18241

J79-GE-10 ENGINES			MK 76 MOD 5 PRACTICE BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			12563	15493	16810	14885	18374	20171
LAST BOMB – FEET	3 BOMBS	60 MSEC	12897	15683	16772	15211	18585	20151
		100 MSEC	13113	15802	16738	15442	18718	20130
		140 MSEC	13322	15915	16698	15667	18846	20103
	4 BOMBS	60 MSEC	13059	15773	16747	15384	18685	20136
		100 MSEC	13374	15942	16687	15723	18877	20095
		140 MSEC	13676	16098	16611	16049	19056	20038
	6 BOMBS	60 MSEC	13374	15942	16687	15723	18877	20095
		100 MSEC	13870	16193	16553	16261	19169	19992
		140 MSEC	14330	16404	16380	16766	19424	19846
	8 BOMBS	60 MSEC	13676	16098	16611	16050	19056	20038
		100 MSEC	14330	16405	16380	16766	19424	19846
		140 MSEC	14913	16632	16074	17417	19722	19570
	12 BOMBS	60 MSEC	14242	16366	16416	16668	19377	19880
		100 MSEC	15141	16705	15919	17677	19828	19426
		140 MSEC	15857	16840	15252	18523	20098	18756

UNCLASSIFIED

FDB-1T-(195-1)

Figure 2-100 (U) (Sheet 1 of 7)

CONLABS PULLUP-TO-IMPACT DISTANCE - CONTINUED

J79-GE-8 ENGINES			MK 81 LDGB BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			13850	17511	19029	16817	21350	23446
LAST BOMB – FEET	3 BOMBS	60 MSEC	14268	17751	18968	17278	21621	23397
		100 MSEC	14539	17901	18916	17577	21792	23354
		140 MSEC	14803	18043	18856	17871	21956	23301
	4 BOMBS	60 MSEC	14472	17865	18930	17503	21750	23366
		100 MSEC	14869	18078	18839	17943	21996	23288
		140 MSEC	15250	18271	18730	18369	22224	23188
	6 BOMBS	60 MSEC	14870	18079	18837	17944	21997	23289
		100 MSEC	15497	18393	18643	18646	22368	23114
		140 MSEC	16081	18653	18399	19305	22689	22880
	8 BOMBS	60 MSEC	15253	18276	18724	18371	22227	23193
		100 MSEC	16084	18658	18392	19308	22693	22885
		140 MSEC	16825	18931	17967	20159	23057	22462
	12 BOMBS	60 MSEC	15978	18617	18438	19184	22638	22944
		100 MSEC	17127	19031	17727	20507	23194	22261
		140 MSEC	18039	19168	16819	21609	23493	21296

J79-GE-10 ENGINES			MK 81 LDGB BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			14002	17803	19512	17006	21704	24015
LAST BOMB – FEET	3 BOMBS	60 MSEC	14430	18054	19459	17477	21986	23978
		100 MSEC	14707	18211	19413	17783	22165	23941
		140 MSEC	14978	18360	19356	18083	22336	23896
	4 BOMBS	60 MSEC	14638	18173	19426	17707	22121	23952
		100 MSEC	15045	18397	19342	18157	22379	23884
		140 MSEC	15436	18630	19236	18593	22618	23797
	6 BOMBS	60 MSEC	15046	18398	19344	18158	22380	23886
		100 MSEC	15691	18732	19157	18877	22771	23730
		140 MSEC	16292	19013	18910	19555	23112	23516
	8 BOMBS	60 MSEC	15440	18607	19243	18596	22622	23801
		100 MSEC	16296	19017	18916	19558	23116	23520
		140 MSEC	17063	19322	18475	20436	23511	23127
	12 BOMBS	60 MSEC	16185	18973	18981	19431	23057	23575
		100 MSEC	17377	19435	18262	20797	23661	22937
		140 MSEC	18337	19627	17293	21946	24013	22019

UNCLASSIFIED
FDB-1T-(195-2)

Figure 2-100 (U) (Sheet 2 of 7)

CONLABS PULLUP-TO-IMPACT DISTANCE - CONTINUED

J79-GE-8 ENGINES			MK 81 SNAKEYE UNRETARDED					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			13171	16461	17854	15838	19844	21743
LAST BOMB – FEET	3 BOMBS	60 MSEC	13549	16676	17804	16248	20083	21707
		100 MSEC	13794	16810	17761	16514	20235	21673
		140 MSEC	14032	16937	17711	16774	20379	21632
	4 BOMBS	60 MSEC	13733	16778	17772	16448	20198	21683
		100 MSEC	14091	16969	17697	16839	20415	21621
		140 MSEC	14434	17143	17604	17215	20616	21541
	6 BOMBS	60 MSEC	14092	16970	17695	16839	20416	21623
		100 MSEC	14657	17252	17529	17460	20744	21481
		140 MSEC	15181	17488	17320	18043	21030	21288
	8 BOMBS	60 MSEC	14438	17147	17599	17218	20619	21546
		100 MSEC	15184	17492	17312	18045	21033	21293
		140 MSEC	15848	17742	16943	18796	21360	20939
	12 BOMBS	60 MSEC	15089	17455	17355	17937	20984	21342
		100 MSEC	16119	17834	16728	19103	21484	20770
		140 MSEC	16938	17972	15925	20075	21764	19948

J79-GE-10 ENGINES			MK 81 SNAKEYE UNRETARDED					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			13308	16716	18272	16004	20147	22227
LAST BOMB – FEET	3 BOMBS	60 MSEC	13693	16940	18230	16422	20395	22201
		100 MSEC	13943	17080	18192	16693	20553	22173
		140 MSEC	14187	17214	18146	16959	20704	22139
	4 BOMBS	60 MSEC	13882	17046	18203	16626	20514	22181
		100 MSEC	14247	17247	18134	17025	20741	22129
		140 MSEC	14599	17431	18045	17410	20952	22060
	6 BOMBS	60 MSEC	14248	17248	18136	17026	20742	22130
		100 MSEC	14828	17547	17979	17661	21087	22006
		140 MSEC	15366	17800	17767	18259	21389	21831
	8 BOMBS	60 MSEC	14602	17435	18051	17413	20955	22064
		100 MSEC	15370	17804	17774	18261	21392	21835
		140 MSEC	16057	18080	17390	19035	21744	21508
	12 BOMBS	60 MSEC	15271	17764	17830	18150	21341	21880
		100 MSEC	16338	18184	17211	19352	21880	21350
		140 MSEC	17187	18368	16344	20363	22203	20572

UNCLASSIFIED

FDB-1T-(195-3)

Figure 2-100 (U) (Sheet 3 of 7)

CONLABS PULLUP-TO-IMPACT DISTANCE - CONTINUED

J79-GE-8 ENGINES			MK 82 LDGP BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			14255	18124	19693	17406	22248	24441
LAST BOMB – FEET	3 BOMBS	60 MSEC	14696	18378	19622	17897	22539	24384
		100 MSEC	14982	18537	19563	18217	22723	24334
		140 MSEC	15262	18687	19495	18530	22989	24275
	4 BOMBS	60 MSEC	14912	18499	19579	18138	22678	24349
		100 MSEC	15332	18725	19476	18608	22942	24260
		140 MSEC	15736	18931	19351	19063	23186	24149
	6 BOMBS	60 MSEC	15334	18728	19479	18610	22944	24263
		100 MSEC	16001	19063	19257	19362	23343	24068
		140 MSEC	16622	19341	18974	20070	23688	23812
	8 BOMBS	60 MSEC	15744	18941	19360	19070	23193	24158
		100 MSEC	16629	19350	18982	20076	23695	23820
		140 MSEC	17422	19645	18481	20993	24087	23361
	12 BOMBS	60 MSEC	16521	19316	19066	19949	23643	23892
		100 MSEC	17756	19767	18264	21380	24246	23155
		140 MSEC	18744	19924	17157	22576	24572	22120

J79-GE-10 ENGINES			MK 82 LDGP BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			14418	18439	20215	17610	22636	25066
LAST BOMB – FEET	3 BOMBS	60 MSEC	14869	18705	20155	18112	22939	25020
		100 MSEC	15162	18872	20104	18439	23131	24978
		140 MSEC	15449	19031	20042	18760	23315	24926
	4 BOMBS	60 MSEC	15090	18832	20119	18358	23084	24990
		100 MSEC	15521	19071	20027	18840	23361	24913
		140 MSEC	15936	19290	19912	19307	23619	24814
	6 BOMBS	60 MSEC	15523	19074	20031	18842	23364	24916
		100 MSEC	16208	19431	19830	19614	23785	24742
		140 MSEC	16849	19731	19565	20343	24153	24505
	8 BOMBS	60 MSEC	15943	19300	19925	19314	23627	24824
		100 MSEC	16857	19741	19577	20350	24161	24514
		140 MSEC	17679	20069	19104	21298	24587	24083
	12 BOMBS	60 MSEC	16745	19704	19658	20219	24107	24584
		100 MSEC	18028	20209	18902	21700	24764	23892
		140 MSEC	19068	20423	17841	22951	25147	22901

UNCLASSIFIED

FDB-1T-(195-4)

Figure 2-100 (U) (Sheet 4 of 7)

CONLABS PULLUP-TO-IMPACT DISTANCE - CONTINUED

J79-GE-8 ENGINES			MK 82 SNAKEYE UNRETARDED					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			13563	17021	18441	16396	20647	22603
LAST BOMB – FEET	3 BOMBS	60 MSEC	13961	17247	18382	16831	20901	22559
		100 MSEC	14218	17389	18333	17114	21061	22519
		140 MSEC	14469	17522	18275	17390	21214	22472
	4 BOMBS	60 MSEC	14155	17355	18346	17044	21022	22531
		100 MSEC	14532	17556	18259	17459	21253	22460
		140 MSEC	14894	17739	18152	17860	21467	22369
	6 BOMBS	60 MSEC	14534	17559	18262	17461	21255	22462
		100 MSEC	15132	17857	18073	18123	21604	22304
		140 MSEC	15687	18105	17829	18744	21906	22091
	8 BOMBS	60 MSEC	14901	17748	18162	17866	21473	22378
		100 MSEC	15693	18114	17838	18750	21913	22099
		140 MSEC	16399	18379	17402	19553	22260	21714
	12 BOMBS	60 MSEC	15597	18084	17912	18639	21868	22160
		100 MSEC	16698	18490	17216	19891	22401	21542
		140 MSEC	17576	18641	16243	20936	22698	20661

J79-GE-10 ENGINES			MK 82 SNAKEYE UNRETARDED					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			13709	17296	18896	16575	20978	23131
LAST BOMB – FEET	3 BOMBS	60 MSEC	14115	17532	18844	17019	21241	23097
		100 MSEC	14378	17680	18801	17308	21409	23065
		140 MSEC	14635	17821	18749	17590	21569	23024
	4 BOMBS	60 MSEC	14313	17645	18813	17237	21368	23074
		100 MSEC	14699	17856	18736	17661	21609	23014
		140 MSEC	15071	18051	18639	18072	21834	22934
	6 BOMBS	60 MSEC	14702	17859	18740	17663	21612	23017
		100 MSEC	15315	18176	18570	18341	21979	22875
		140 MSEC	15886	18443	18344	18980	22300	22681
	8 BOMBS	60 MSEC	15078	18060	18651	18078	21841	22943
		100 MSEC	15893	18453	18354	18986	22308	22689
		140 MSEC	16624	18746	17946	19814	22682	22330
	12 BOMBS	60 MSEC	15795	18419	18425	18872	22261	22748
		100 MSEC	16935	18872	17773	20165	22839	22171
		140 MSEC	17858	19073	16846	21255	23184	21332

UNCLASSIFIED

FDB-1T-(195-5)

Figure 2-100 (U) (Sheet 5 of 7)

CONLABS PULLUP-TO-IMPACT DISTANCE - CONTINUED

J79-GE-8 ENGINES			MK 83 LDGP BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			14498	18481	20069	17759	22780	25018
LAST BOMB – FEET	3 BOMBS	60 MSEC	14953	18744	19994	18267	23081	24954
		100 MSEC	15249	18910	19931	18598	23271	24898
		140 MSEC	15538	19066	19857	18922	23451	24831
	4 BOMBS	60 MSEC	15177	18871	19950	18516	23224	24913
		100 MSEC	15611	19106	19842	19003	23496	24814
		140 MSEC	16030	19321	19710	19473	23747	24692
	6 BOMBS	60 MSEC	15616	19113	19851	19004	23497	24816
		100 MSEC	16309	19465	19625	19780	23907	24601
		140 MSEC	16955	19758	19332	20511	24258	24320
	8 BOMBS	60 MSEC						
		100 MSEC						
		140 MSEC						
	12 BOMBS	60 MSEC						
		100 MSEC						
		140 MSEC						

J79-GE-10 ENGINES			MK 83 LDGP BOMB					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			14667	18810	20615	17972	23188	25676
LAST BOMB – FEET	3 BOMBS	60 MSEC	15132	19086	20552	18493	23504	25626
		100 MSEC	15435	19260	20498	18834	23705	25581
		140 MSEC	15732	19425	20433	19167	23897	25525
	4 BOMBS	60 MSEC	15361	19219	20514	18750	23657	25595
		100 MSEC	15807	19468	20420	19252	23946	25513
		140 MSEC	16237	19697	20301	19738	24216	25409
	6 BOMBS	60 MSEC	15812	19476	20429	19256	23953	22521
		100 MSEC	16525	19851	20225	20063	24396	25339
		140 MSEC	17193	20169	19954	20826	24782	25093
	8 BOMBS	60 MSEC						
		100 MSEC						
		140 MSEC						
	12 BOMBS	60 MSEC						
		100 MSEC						
		140 MSEC						

UNCLASSIFIED

FDB-1T-(195-6)

Figure 2-100 (U) (Sheet 6 of 7)

CONLABS PULLUP-TO-IMPACT DISTANCE - CONTINUED

J79-GE-8 ENGINES			M117A1 BOMB WITH M131 FIN					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.57	39.13	55.29	26.88	37.31	53.32
FIRST BOMB – FEET			14203	18008	19536	17319	22073	24212
LAST BOMB – FEET	3 BOMBS	60 MSEC	14639	18258	19466	17802	22359	24156
		100 MSEC	14921	18415	19407	18118	22539	24108
		140 MSEC	15197	18563	19338	18426	22711	24049
	4 BOMBS	60 MSEC	14852	18378	19424	18040	22496	24122
		100 MSEC	15267	18601	19323	18504	22755	24036
		140 MSEC	15667	18805	19198	18952	22996	23928
	6 BOMBS	60 MSEC	15271	18606	19330	18507	22759	24040
		100 MSEC	15931	18939	19115	19249	23153	23852
		140 MSEC	16546	19216	18836	19948	23494	23603
	8 BOMBS	60 MSEC	15678	18821	19219	18962	23008	23942
		100 MSEC	16557	19231	18855	19957	23506	23616
		140 MSEC	17344	19528	18366	20864	23897	23171
	12 BOMBS	60 MSEC						
		100 MSEC						
		140 MSEC						

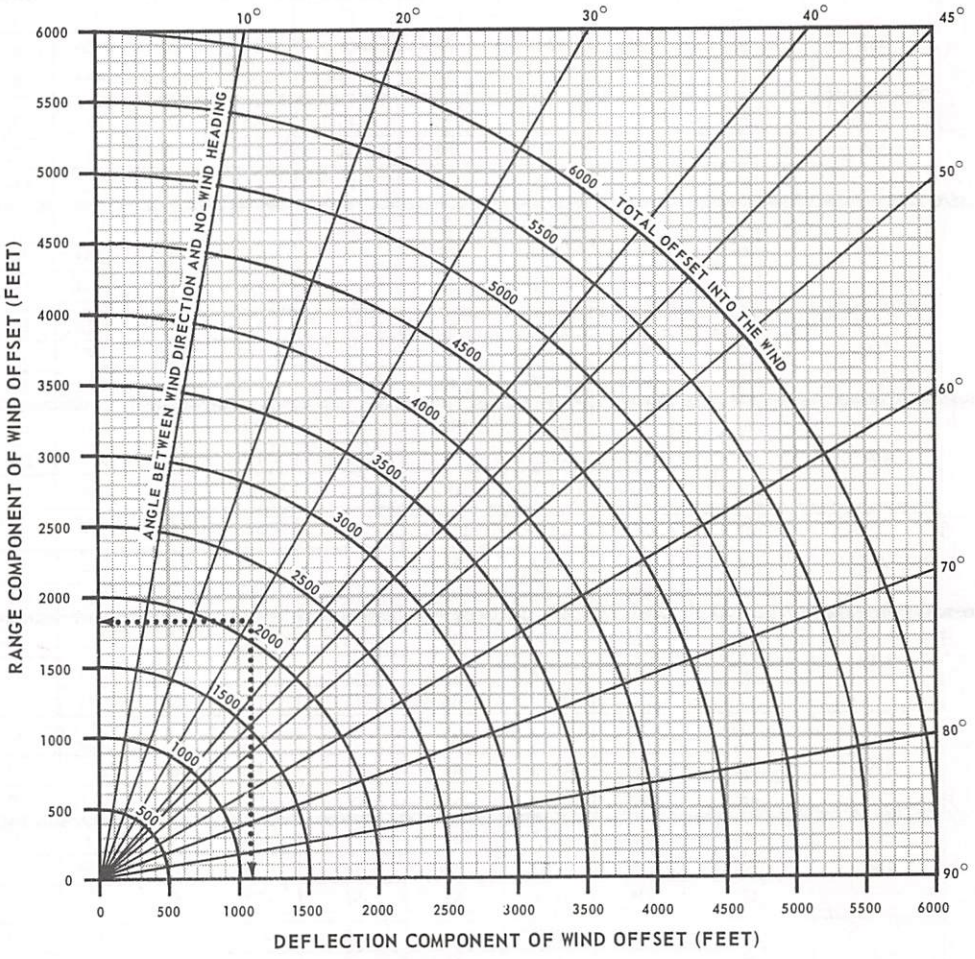
J79-GE-10 ENGINES			M117A1 BOMB WITH M131 FIN					
			450 KTAS APPROACH			500 KTAS APPROACH		
INITIAL RELEASE ANGLE			20°	30°	45°	20°	30°	45°
LABS SECTOR SETTING			28.43	38.92	55.10	26.77	37.14	53.04
FIRST BOMB – FEET			14364	18318	20049	17520	22454	24825
LAST BOMB – FEET	3 BOMBS	60 MSEC	14809	18580	19991	18014	22751	24780
		100 MSEC	15099	18745	19940	18337	22940	24739
		140 MSEC	15382	18902	19880	18653	23121	24688
	4 BOMBS	60 MSEC	15028	18706	19956	18258	22895	24752
		100 MSEC	15453	18942	19866	18733	23167	24677
		140 MSEC	15864	19159	19754	19193	23421	24580
	6 BOMBS	60 MSEC	15457	18948	19874	18736	23172	24682
		100 MSEC	16136	19303	19680	19498	23588	24514
		140 MSEC	16770	19602	19422	20217	23952	24285
	8 BOMBS	60 MSEC	15876	19176	19776	19203	23435	24597
		100 MSEC	16782	19617	19442	20227	23965	24300
		140 MSEC	17598	19948	18983	21165	24390	23883
	12 BOMBS	60 MSEC						
		100 MSEC						
		140 MSEC						

UNCLASSIFIED

FDB-1T-(195-7)

Figure 2-100 (U) (Sheet 7 of 7)

CONLABS WIND OFFSET COMPONENTS



UNCLASSIFIED
FDB-1T-(196)

Figure 2-101 (U)

CONLABS CORRECTIONS

NOTE: ALL CORRECTIONS ARE IN FEET

WEAPON	RUN IN AIRSPEED KTAS	INITIAL RELEASE ANGLE DEG	RUN-IN AIRSPEED +10 KTAS	RUN-IN AIRSPEED -10 KTAS	RUN-IN ALTITUDE +100 FEET	TARGET ALTITUDE +1000 FEET	GROSS WEIGHT +1000 LBS	GROSS WEIGHT -1000 LBS	TEMPERATURE +10 °C	TEMPERATURE -10 °C	WIND CORRECTION FACTOR (FEET PER KNOT OF WIND)
MK 76 MOD 5 PRACTICE BOMB	450	20	530	-534	124	+10	-55	54	-36	27	42
		30	639	-647	75	-14	-98	94	-105	93	56
		45	674	-664	43	-13	-101	132	-149	185	71
	500	20	511	-512	126	+45	-45	47	+10	-22	46
		30	604	-607	83	+38	-75	77	-36	22	61
		45	660	-663	44	-11	-117	119	-145	126	79
MK 81 LDGP	450	20	692	-689	147	-45	-75	72	-121	127	42
		30	846	-849	87	-96	-135	131	-234	241	56
		45	878	-861	45	-102	-149	113	-294	356	71
	500	20	709	-700	152	-15	-63	68	-102	111	46
		30	844	-837	97	-47	-110	114	-191	204	61
		45	889	-886	47	-115	-168	172	-325	334	79
MK 82 LDGP	450	20	738	-733	152	-63	-80	78	-147	157	42
		30	908	-909	89	-124	-147	142	-274	289	56
		45	938	-918	45	-132	-164	199	-340	412	71
	500	20	763	-753	158	-38	-69	74	-135	149	46
		30	915	-907	99	-81	-121	126	-241	263	61
		45	959	-953	47	-154	-184	188	-385	405	79
MK 83 LDGP	450	20	766	-759	154	-74	-84	81	-162	175	42
		30	946	-945	90	-141	-154	149	-300	318	56
		45	974	-953	45	-151	-172	208	-368	446	71
	500	20	796	-784	161	-52	-48	78	-155	173	46
		30	960	-950	101	-102	-127	133	-272	301	61
		45	1001	-994	46	-178	-194	198	-422	450	79
MK 81 SNAKEYE UNRETARDED	450	20	618	-617	137	-17	-65	64	-82	82	42
		30	747	-752	82	-54	-117	114	-171	169	56
		45	780	-766	45	-56	-126	158	-222	271	71
	500	20	622	-617	141	+17	-55	59	-54	56	46
		30	733	-730	91	-1	-93	97	-118	121	61
		45	780	-779	47	-60	-143	146	-235	233	79
MK 82 SNAKEYE UNRETARDED	450	20	659	-656	142	-31	-70	69	-103	107	42
		30	799	-804	84	-75	-127	123	-204	207	56
		45	830	-814	45	-79	-138	171	-259	315	71
	500	20	669	-662	146	1	-60	64	-81	86	46
		30	791	-787	94	-24	-102	106	-157	165	61
		45	838	-834	47	-87	-156	160	-282	286	79
M117A1 BOMB WITH M131 FIN	450	20	729	-725	150	-59	-79	77	-142	151	42
		30	896	-897	88	-118	-144	140	-266	278	56
		45	924	-905	45	-126	-161	195	-330	400	71
	500	20	752	-742	156	-33	-68	73	-128	141	46
		30	900	-892	98	-73	-118	123	-230	250	61
		45	943	-938	47	-145	-180	184	-371	389	79

UNCLASSIFIED

FDB-1T-(197)

Figure 2-102 (U)

SECTION III
AIRCRAFT EMPLOYMENT

TABLE OF CONTENTS

PART I AIR INTERCEPT CONTROL . . . 3-1
Interceptor Control Techniques 3-1
Vectoring 3-4
Intercept procedures 3-6
Controller Vectoring to Final Attack Position 3-8
PART 2 EMPLOYMENT CONSIDERATIONS 3-10
Performance 3-10
Factors Affecting Employment of CAP or DLI 3-18
CAP Stationing 3-20

PART 1 AIR INTERCEPT CONTROL

(C) In the Anti-Air Warfare environment, each intercept of a raid is divided into three distinct phases: detection, approach, and attack. The detection phase includes initial raid detection, raid evaluation and tracking. The mechanics and procedures for this phase are adequately covered in current NWP series publications. The approach phase starts when the air intercept controller (AIC) commences the interception with an assigned CAP. The phase terminates when the interceptor achieves radar or visual contact with the raid and assumes control of the intercept. The approach phase is under the direction of the AIC and includes vectoring, runout, identification and interceptor positioning for an attack. The approach phase of the intercept is considered the most critical and most important phase. There is little probability that the interceptor can locate, identify, and destroy a target without the support of a qualified AIC. On the other hand, if incorrect run-out altitudes and speeds are directed, the interceptor may not acquire radar or visual contact, or may have insufficient fuel or speed to complete the attack. If AIC vectoring is erroneous, the interceptor may never achieve a successful missile launch position even though the raid is detected. The AIC controls the main fleet defense, the fleet interceptor.

INTERCEPTOR CONTROL TECHNIQUES

(U) GENERAL

(C) The interceptor weapon system is optimized in head-on attacks against all targets. Advantages of a head-on attack are: the performance characteristics of the aircraft are used to their best advantage; the enemy cannot penetrate as deeply; the interceptor is in the optimum position to counter target evasive maneuvers or countermeasures, the simplest approach and attack solutions for the AIC and interceptor aircrew are presented. Realize that the preceding is true only if certain criteria are met; i.e., working radar, good AIM-7 missiles, and cleared to fire.

(U) ARMAMENT

(C) In response to an AIC request for state report, the aircrew will indicate the number of semiactive and passive missiles, in that order. The interceptor is equipped with semi-active AIM-7 (Sparrow III) missiles and infrared homing AIM-9 (Sidewinder) missiles. The AIM-7 missile is an all aspect, all-weather weapon, and is considered to be the primary armament during all attacks from the forward hemisphere and in addition, the AIM-7 is used in stern attacks if environmental conditions dictate. Since the AIM-9 missile homes on infrared energy emitted from the engines of a target aircraft, the maximum infrared envelope is in the stern area. Because IR energy is dissipated in clouds, its use is limited to clear weather. The AIM-9 is used from all aspects in the event of an AMCS failure; however, if not fired from the rear hemisphere, degraded results will occur.

(U) CAP STATIONING

(C) CAP stationing considerations are discussed in detail in part 2 of this section. The AIC does not normally have control over the assignment of CAP stations or CAP altitudes; this perrogative rests with AAW commanders and is based upon the expected threat. On CAP station, the airplane normally flies a pattern oriented in the direction of the expected attack. The AIC must maintain a continuous track of the airplane on CAP station. The pilot flies the required pattern remaining within 20 miles of the assigned CAP station at all times. The RIO uses his

(C)
aircraft radar for search at all times. Experience has shown that the interceptor radar adds significantly to the AEW capability of the fleet.

(U) COMMUNICATIONS

(C) NWP-32 Series outlines Radio Telephone (R/T) procedures. ACP 165B contains the Operational Brevity Codes. It is mandatory that all members of the AIC/interceptor team are thoroughly familiar with prowords and brevity codes promulgated for air intercept control. The published procedures must be modified to meet the tactical situation since, in the presence of communication jamming, it may not be possible to complete all of each transmission. Communication jamming aircraft generally operate the jamming equipment in one of two modes, continuously on the fighter direction frequency or only when the AIC or CAP attempt to transmit. There are advantages and disadvantages to both procedures. With the communications jamming equipment operating continuously, the jamming is more effective but the jamming aircraft renders itself especially vulnerable to intercept since the interceptor can use direction finding (DF) techniques for homing. When the jamming equipment is activated only when the AIC or CAP attempt to transmit, the jamming is slightly less effective but DF homing on the jamming aircraft is much more difficult because the jammer is not on long enough for accurate bearing determination. It is possible to shift frequencies, but this procedure does not always solve the problem, therefore, the requirement exists for overcoming or reading through the jamming. It has been determined that the most effective procedure to counter communication jamming is to modify the brevity code so that transmissions are as brief and concise as possible to reduce the time that the jamming aircraft has available to search for and jam the transmitting communication frequency. In addition, intercommunication between pilot and RIO is required for successful intercepts.

(U) CLOSE AIR INTERCEPT CONTROL

(C) To employ close air intercept control effectively, the controller must have a continuous updated plot on both the CAP and the raid. The AIC vectors the interceptor toward the threat and recommends altitude and airspeed up to the time the aircrew takes control of the intercept. Target magnetic bearing, range, altitude, and speed are transmitted relative to the interceptor position. The aircrew follows the AIC's directions until ready to assume control of the intercept and start the attack phase. This type of control is preferable because the AIC is aware of the total problem and positions the interceptor for an attack in relation to the total tactical situation. The aircrew is left free to search for the target, detect it, counter enemy maneuvers and countermeasures, and deliver the missile.

(U) BROADCAST CONTROL

(C) There will be times when the AIC will be charged with the responsibility of employing several CAP's to intercept several raids. The intercept control technique which has proven most effective in these situations is broadcast control. This procedure differs from close control in that the broadcaster transmits target range and bearing from a known TACAN station or geographical point. The aircrew plots this position and CAP position, plans the intercept geometry, and establishes the required heading, altitude, and airspeed to achieve intercept. The approach phase is under the control of the interceptor aircrew rather than the AIC. Target heading, altitude, and speed information is included in target position transmission. Though less desirable than close air intercept control, broadcast control has proven to be an effective intercept technique for this airplane. The excellent long range search characteristics of the AI radars tend to increase this capability. The major disadvantage to broadcast control is the vulnerability of communications to deception and jamming. Effective broadcast control is completely dependent upon accurate target position information at regular intervals. Degradation in communications significantly reduces intercept success probability. The mechanics and procedures for broadcast control are discussed in detail in NWP-32 Series.

(U) RUN-OUT SPEED

(C) The airplane, in a fleet configuration, is capable of speeds from 500 KTAS to approximately 1000 KTAS; therefore, the run-out speed selected for the initial vector is of prime importance and will normally be selected by the aircrew. The run-out speed selected should satisfy three fundamentals: it should place the intercept as far out as reasonably possible with respect to the expected threat; it should provide the interceptor with sufficient basic speed to match the raid maneuvers and to commence the attack; and it should accomplish this with a minimum depletion of the combat fuel package.

(U) RUN-OUT ALTITUDE

(C) Another critical factor in the intercept profile which must be considered by the AIC is the run-out altitude. The optimum run-out altitude is based upon the altitude of the raid, the relative position of the interceptor and the raid, the interceptor maneuverability and speed required, atmospheric conditions and the altitude from which the attack phase should be started. All these variables are generally well within the cognizance of the aircrew. The selection of run-out altitude should be a matter of crew selection once target altitude information is transmitted. The crew should advise the AIC of the desired run-out altitude at the time. Basic run-out altitudes against the various threats are included under Intercept Procedures, this section.

(U) RATE-OF-TURN

(C) The rate-of-turn used by the interceptor during the run-out affects positioning for the attack phase as much as the run-out speed and altitude. The following rates of turn should be used by the aircrew throughout the intercept until JUDY: 3° per second

(C)
for HARD turns and 1-1/2° per second for STANDARD turns. Initial vectors will be maximum rate turns.

(U) FUEL CONSIDERATIONS

(C) Of primary importance to the AIC is the CAP fuel state and the combat fuel available for intercept. It is impractical to require that the AIC have a full and complete knowledge of the interceptor fuel consumption at all altitudes and configurations. Experience has shown that fuel consumption is best managed by the aircrew. The AIC requires only a few basic facts on fuel consumption for adequate intercept control and speed command judgment. Figure 3-1 may be used for rough fuel consumption during intercept run-out. The following thumb rules can be used in determining fuel consumption for the standard CAP configurations:

CONDITIONS (ALL ALTITUDES)	FUEL CONSUMPTION
CAP Station Holding	5500 pounds per hour
Full Military Power (Buster)	12,000 pounds per hour
Maximum Power (Gate)	1500 pounds per minute

(C) When communications interception is possible, the aircrew should use the following prowords concerning fuel state to provide the AIC estimates of CAP availability and relief or refueling requirements.

PROWORD	CAP CONDITION
STATE TIGER	Sufficient fuel available for at least one intercept with 5 minutes of GATE.
STATE LAMB	Sufficient fuel for at least one intercept at BUSTER. No fuel for a maximum power intercept.
STATE CHICKEN	Insufficient fuel for any intercept. Require immediate recovery or air refueling.
STATE SHEEP	Followed by a time in minutes; indicates that the CAP must be steered for recovery or air refueling in the specified time; e.g., STATE SHEEP THIRTY. Require a steer or refueling in 30 minutes.

(U) LIMITATIONS OF PULSE RADAR

(C) There are certain basic limitations of pulse radars which are inherent to all pulse radars and which must be understood by the AIC to realize the most effective employment of the system.

RUN-OUT FUEL/TIME

CONFIGURATION:

(2) J79-GE-8 ENGINES
(4) AIM-7 MISSILES
(4) AIM-9 MISSILES
GROSS WEIGHT – 40,000 POUNDS

FUEL CONSUMED IN 10 MILES LEVEL FLIGHT (POWER REQUIRED)

ALT.	0.9M	1.0M	1.1M	1.2M	1.3M
S.L.	340 LB	890 LB	1154 LB	–	–
15,000	198 LB	429 LB	560 LB	694 LB	793 LB
30,000	120 LB	253 LB	345 LB	357 LB	400 LB
45,000	177 LB	212 LB	239 LB	253 LB	263 LB

AVERAGE SPEED DURING 1.5 MACH ACCELERATION AND RUN-OUT

TIME (MIN)	SPEED (MACH NUMBER)	AVE SPEED (MACH NUMBER)
0	0.9	0.9
1	1.05	0.98
2	1.15	1.03
3	1.24	1.08
4	1.38	1.12
5	1.50	1.20
6	1.50	1.24
7	1.50	1.28
8	1.50	1.30
9	1.50	1.32
10	1.50	1.34

FUEL REQUIRED TO ACCELERATE FROM 0.9M (MAXIMUM POWER)

ALT	1.0M	1.1M	1.2M	1.3M	1.4M
10,000	149 LB	421 LB	845 LB	1681 LB	–
15,000	140 LB	371 LB	696 LB	1177 LB	2099 LB
30,000	133 LB	324 LB	550 LB	804 LB	1088 LB
45,000	287 LB	681 LB	1106 LB	1538 LB	1960 LB

CONFIDENTIAL
FDB-1T-(198)

Figure 3-1 (C)

(U) Clutter

(C) The electronic characteristics of the interceptors radar scope tend to increase the effects of scope clutter due to sea state or heavy weather. Intercept in these conditions generally results in decreased detection ranges and difficulty in automatically tracking the target. Because of decreased detection ranges and tracking problems, lost contact reports should be anticipated and the AIC must plan the intercept based upon minimum time and distance for maneuvering and missile launching in the attack phase. The success of intercepts under these conditions is primarily a controller function.

(U) Altitude Information

(C) By design, the radar concentrates radiated energy into a very narrow beam, both in elevation and azimuth. An automatic azimuth sweep feature is incorporated in the search mode, but elevation settings are manual and operator controlled. Accurate target altitude information is essential so that the proper elevation setting can be used for maximum range detections.

(U) LIMITATIONS OF PULSE DOPPLER RADAR

(C) The AIC must be aware of the limitations and capabilities of pulse doppler radar when planning intercepts for F-4J aircraft. When searching in pulse doppler, the RIO is looking for targets at a specific azimuth and velocity. The target appears at a relative velocity on the radar scopes, but range information is not available to the aircrew until pause-to-range or automatic track is initiated. Therefore, it is essential that the AIC keep the RIO supplied with azimuth, closing velocity, elevation, and range information. Closing velocity is the most critically required information since the AN/APG-59 radar in pulse doppler search presents an azimuth vs velocity display instead of the azimuth vs range display of the AN/APQ-72. In a multiple target environment both the closing velocity and range of each target is essential to the F-4J aircrew to ensure a rapid assessment of the most immediate threat.

Note

The most significant consideration is the fact that the F-4J may be operating with pulse only. The PD system is effective only when geometry produces closure rates greater than the fighters velocity. The system does not present targets within ± 110 knots of the fighter speed.

VECTORING

(U) GENERAL

(C) The methods discussed in this portion are defensive in nature and do not necessarily apply in all situations. When a raid is designated to the AIC for interception with the assigned CAP, the controller must first make the determination of the type of vectoring to be used. This decision will be based upon the relative position of the raid and the CAP, and will be influenced by the desired missile launch position and the requirement to position the interceptor between the raid and the vital area. The optimum interceptor attack in all instances, except as noted in Lead Pursuit Vectoring, is in the forward hemisphere of the target with a TCA at launch of from 130° to 180°. The type vectoring employed by the AIC should be based upon their attack position. Two basic types of interceptor vectoring are: lead collision and lead pursuit.

(U) DEFENSIVE POSITIONING

(C) Defensive positioning is the positioning of the interceptor on the radial of the raid from the vital area, and then vectoring out toward the raid. This technique is specifically designed to protect the vital area when the raids employ jinking tactics and feints, and when fade zones and communications jamming are expected. Once on the radial of the raid, the CAP is maintained on this radial with radial changes as required to compensate for target position changes. The effect of jinking and fade zones on defensive positioning is illustrated by raid E and F of figure 3-2. In both situations the interceptor (CAP E and CAP F) was in position between the raid and the vital area when the raid turned in to threaten the task force. If the raid does not turn in toward the force, the interceptor can be either vectored out or resumed to await succeeding raids. Although defensive positioning might appear to permit increased raid penetration, it actually results in reliable midrange intercepts. Raid jinking slows down raid advance at about the same rate that defensive positioning slows down interceptor run-out. The primary disadvantage to defensive positioning is that it may not always be possible to achieve the desired front quarter approach and attack. The many advantages in interceptor positioning to counter evasive maneuvering and target raids compensates for the major disadvantage.

(U) COLLISION VECTORING

(C) Collision vectoring is the establishment of a lead angle which maintains a constant true bearing and closing range rate to the target. It is the most rapid means of closing the target, and provides intercept with minimum maneuvering. If the target maneuvers, a bearing drift will occur and a minor heading change is made to re-establish the collision. Minor target speed changes that would not normally be noticed in

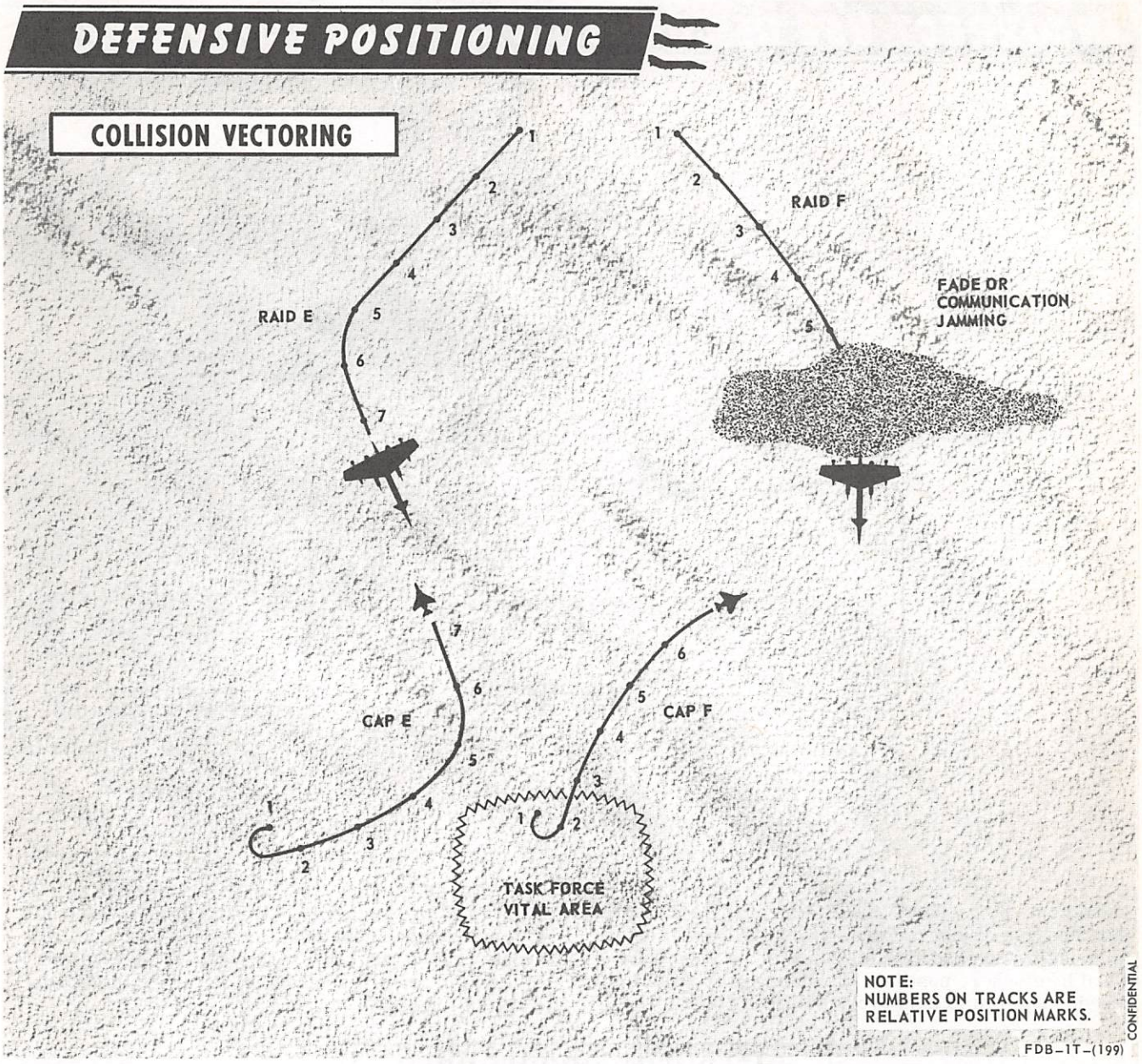


Figure 3-2 (C)

(C)

track or plot will be immediately noticed and compensated for in this approach method. If the CAP station is positioned between the vital area and the threat, this method will normally end in a forward hemisphere approach as illustrated in figure 3-2, position 5. After AI radar contact is gained and lockon is achieved, the interceptor crew is free to maneuver at will for the most effective missile launch position. Lead collision is necessary if the target is carrying a stand-off weapon (necessitates interception as far from the vital area as possible), or if initial target detection was made at short range (intercept time must be reduced to complete the intercept before the target is over the vital area). Over ambitious use of collision vectoring and disregarding vital area protection may result in the situation illustrated in figure 3-3.

(U) LEAD PURSUIT VECTORING

(C) Lead pursuit vectoring is a technique of experienced air controllers, and should only be used if the interceptor radar is inoperative or passive missiles only are available. This method requires the controller to vector the interceptor toward the target, and establish track displacement between target track and interceptor track. The controller must determine when the interceptor is in position to execute a turn to close the target track in order to arrive in position to execute a turn to target heading, arriving in missile envelope. Initially the displacement allows maneuvering room required for the two 90° turns, a short level flight to reacquire the target either on AI radar or visually, and to make correction maneuvers if the target jinks. Lead pursuit vectoring

INCORRECT USE OF COLLISION COURSE VECTORING

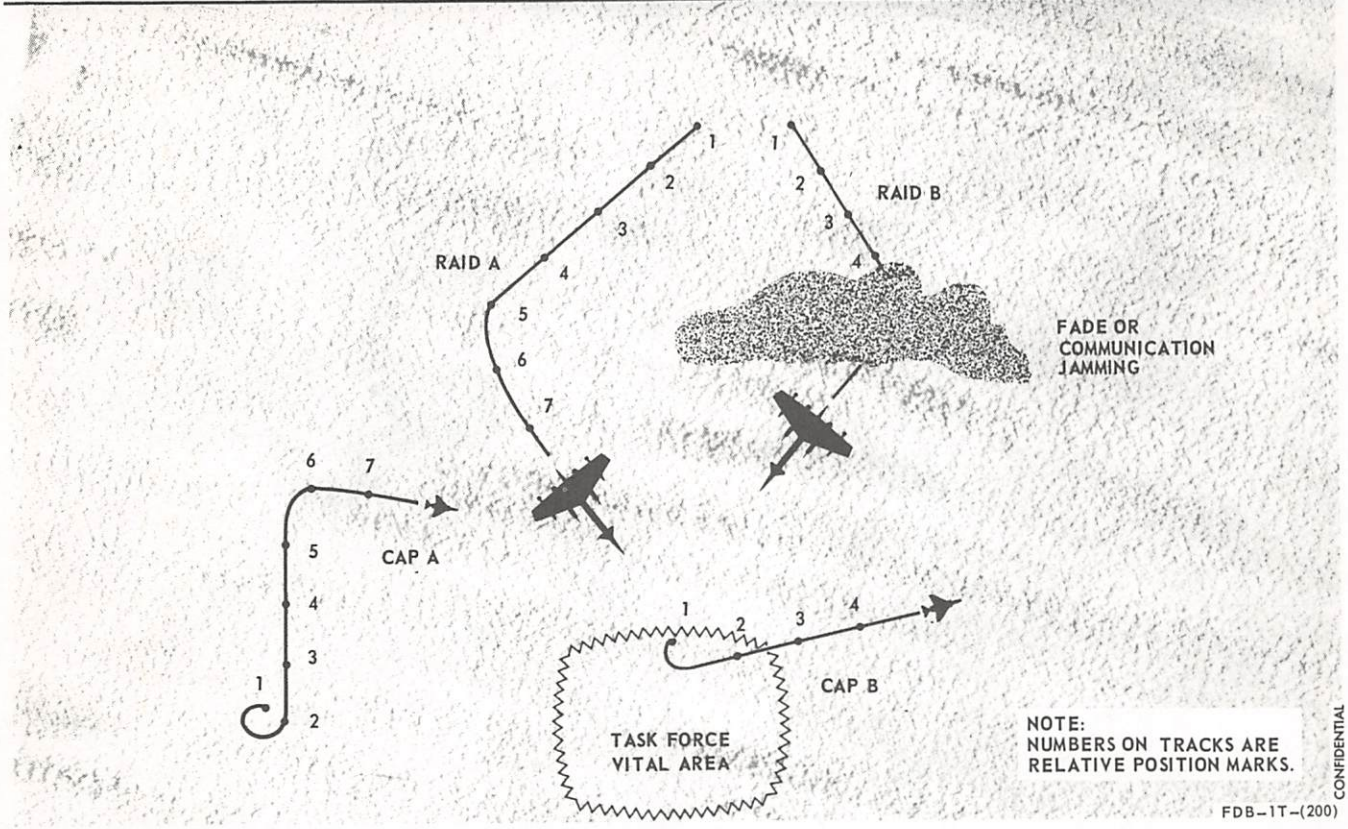


Figure 3-3 (C)

(C)
should only be used with the F-4 aircraft as a last resort because of aircraft maneuvering capabilities of arriving in the passive missile envelope from a forward hemisphere position. In addition, excessive fuel is required to gain overtake speed if the interceptor is detected and the target jinks away. as well as permitting the target additional penetration while gaining displacement and stern firing position. Extreme caution must be exercised to avoid an excessive tail chase or passing ahead of the raid as indicated in figure 3-4.

INTERCEPT PROCEDURES

(U) LOW ALTITUDE RAIDS

(C) Low altitude raids are considered to be those between 2000 and 10,000 feet. The recommended run-out speed against low level and very low level (0-2000 feet) raids is 500 KTAS. The recommended run-out altitude against very low raids is 200 feet. This generally permits a look-up at the target to optimize radar detection and tracking performance. At raid altitudes between 2000 and 10,000 feet, the recommended run-out altitude is co-altitude or an altitude up to 2000 feet below the target.

(U) Attacking Low Altitude Raids

NEW (C) The F-4B/N and F-4J weapon systems are degraded against low targets, particularly against very low targets, and it has been determined that a forward hemisphere attack gives the system its best chance for a successful intercept. It has been determined that radar detection and track is less difficult in forward approaches than in beam or rear hemisphere approaches. In forward hemisphere approaches, relative motion is higher and more easily discernible. The aircrew may concentrate on target detection and tracking with limited maneuvering required for a missile launch. Target tracking capability depends on sea state and relative altitude rather than TCA. In those cases where automatic track cannot be maintained, the forward hemisphere attack places the interceptor in the optimum position for an AIM-7 launch in the alternate missile launch modes. Airplane performance characteristics will generally permit maneuvers for a re-attack without excessive raid penetration if the primary AIM-7 attack is unsuccessful. In situations where sea states are NEW

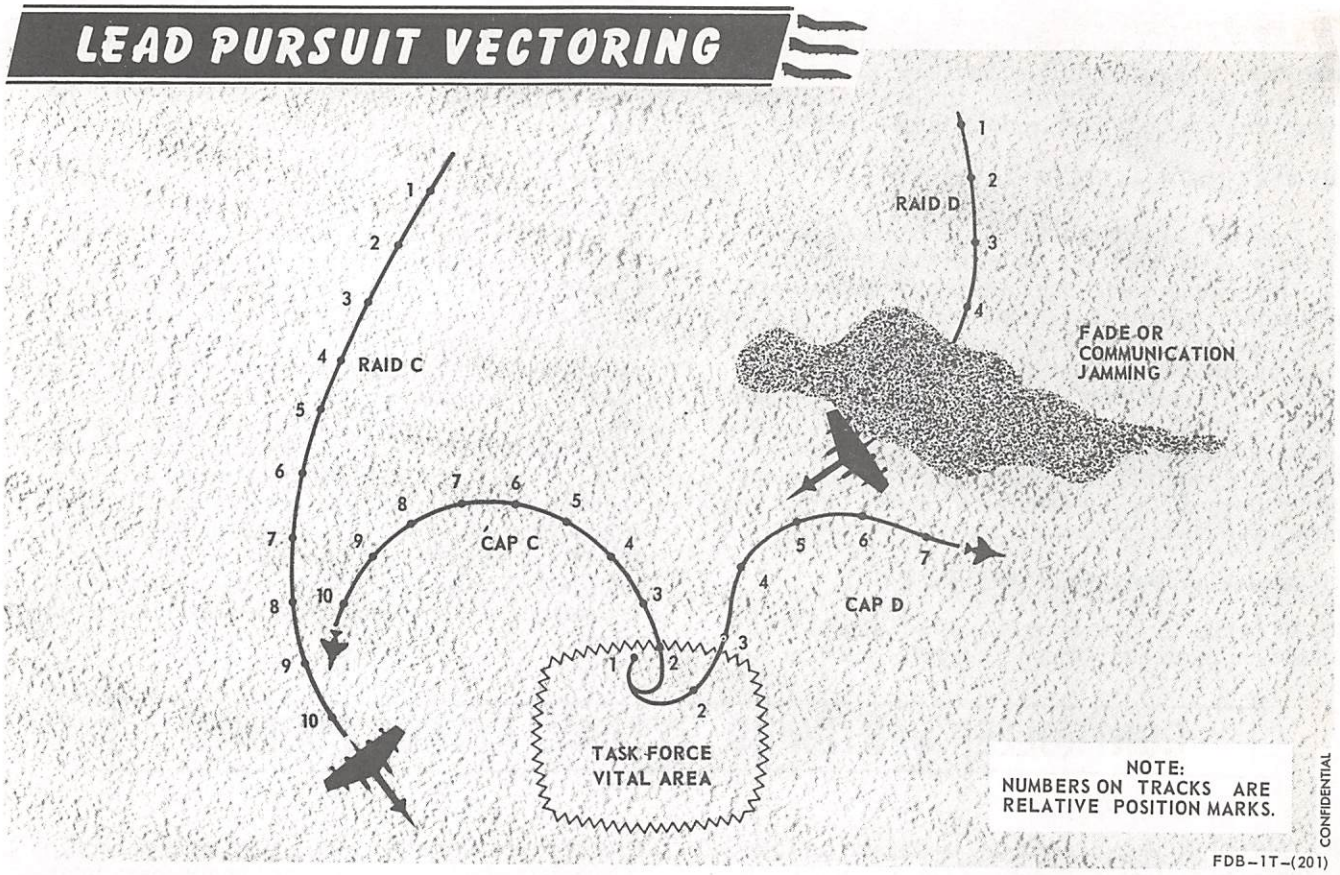


Figure 3-4 (C)

(C)
STATE 3 or higher (surface wind velocity 25 knots or higher) successful pulse radar detection and tracking of very low altitude targets is problematical. In addition to radar limitations, the AIM-7 kill probability is significantly reduced against low altitude targets in high sea state conditions. If these conditions are present, the AIC should vector the CAP for a stern attack. The assumption is that the radar will be ineffective for detections, and that the attack will be made after visual contact with the target.

(U) MEDIUM AND HIGH ALTITUDE RAIDS

(C) Medium altitude raids are categorized as those raids between 10,000 and 40,000 feet. The major countermeasure and jinking threats are concentrated in this area. The recommended run-out speed and altitude against medium altitude raids is 500-550 KTAS at 20,000 to 25,000 feet. This speed and altitude combination provides for adequate rate of closure with the raid while providing for reduced fuel consumption and interceptor maneuverability. Rates of turn as directed by controller are used until JUDY is obtained. It is not anticipated that medium and high altitude targets will penetrate at supersonic speeds. Intelligence estimates indicate that this threat operates between 20,000 and 40,000 feet, has an all inclusive IRCM and ECM capability against radar and communications, and is equipped with air-to-surface missiles. These raids represent the most serious threat to the fleet and provide the most difficult intercept problems to the interceptor aircrew. The raids incorporate I(X)-band passive warning equipment to determine the interceptor search or tracking mode and approach aspect. Evasive maneuvering will be used to place the interceptor in the least advantageous missile launch position and in the least desirable position to counter countermeasures.

(U) Attacking Medium and High Altitude Raids

(C) A forward hemisphere, specifically a head-on approach, will place the interceptor in the best relative position to counter target evasive maneuvering and combat countermeasures. Target evasive turns may preclude a head-on attack with the AIM-7, but may permit a front quarter or rear hemisphere attack without excessive raid penetration. The forward hemisphere approach additionally provides the best tactic against countermeasures. If automatic tracking cannot be accomplished, the interceptor is in the optimum position to employ one of the alternate missile launch modes. Lead collision vectoring against these raids will tend to decrease the effects of communications jamming. The initial vectors to position the CAP on a collision with the raid will be transmitted while the interceptor is at a relatively close range. When established on a collision vector and proceeding out to the intercept, the CAP will close

(C) the target and communications jamming will be more effective. The probability of intercept, however, is not reduced significantly since very little additional vectoring is usually required for target detection.

(U) VERY HIGH ALTITUDE RAIDS

(C) Very high altitude raids are defined as those raids above 40,000 feet. As in the case of low and medium altitude raids, high altitude raids are best approached using lead collision vectoring procedures. Very high altitude raids may be supersonic or subsonic and the recommended run-out altitude and speed is approximately 40,000 feet at 1.1 to 1 speed ratio. This altitude is the best for acceleration and maneuvering during the approach and attack phases. This speed realizes some reduction in fuel consumption while ensuring adequate performance to climb to co-altitude during the attack phase.

(U) Attacking Very High Altitude Raids

(C) Very high altitude targets are best approached in a head-on intercept. These raids, like medium altitude raids, are expected to be equipped with countermeasures equipment, including passive I(X)-band warning devices. The presence of, and approach aspect of the intercept will be known. Very high altitude raids are expected to employ evasive maneuvers based upon knowledge of interceptor aspect, to counter interception. Evasive turns by these raids, combined with countermeasures against the AI radars, present formidable detection, tracking and maneuvering problems to the interceptor crew. Counter-countermeasure techniques are the same as those against medium altitude targets except that the closure rate requires a very rapid analysis of the situation and spontaneous operator action. A target evasive turn, again because of closure rate, is an extremely effective maneuver to disrupt the intercept. The interceptor must turn a minimum of twice as far as the target to counter the target turn and center the steering dot for a missile launch. The AIM-7 probability of kill is significantly reduced if the TCA at launch is between 130° and 60°. Maximum AIM-7 capability against high altitude targets is realized in a head-on attack, co-altitude with the target.

CONTROLLER VECTORING TO FINAL ATTACK POSITION

(C) Certain ECM environments, weather conditions, and weapon system malfunctions may prevent the interceptor flight crew from detecting and/or tracking a target to achieve a final attack position. In these situations, the AIC will normally be required to vector the interceptor to a position from which a stern attack may be made (figure 3-5). The AIC should plan to vector the interceptor to a stern attack if:

a. The APQ-72 or APG-59 radar is inoperative, requiring that missiles be launched visually; and/or
b. The target is at very low altitude over a sea state of three or higher. In this environment the capability of the weapon system is seriously degraded, and it is probable that the target cannot be detected or tracked.

(C) The requirements for AIC final positioning under other circumstances is less clearly defined. The optimum intercept terminates in a forward hemisphere attack, preferably head-on. While vectoring the fighter for this approach, the AIC must be alert to the fact that the planned intercept may not be possible and a conversion to a stern attack may be required. There is a point in each forward hemisphere intercept beyond which a stern attack cannot be made without a prolonged tail chase. This point must be determined by the air controller during each intercept. Its location may be derived from the tactical situation and the AIC knowledge of the turning radius and rate-of-turn of the interceptor at various speeds and altitudes. As closing velocity and target altitude increase, the conversion must be made at greater range from the target. A conversion to a stern attack will not only deny the aircrew additional time to search for and detect the target, but also will generally be made from a less than ideal position. The alternative, however, may be a missed intercept. The important point is that the AIC should compute the point at which the conversion must be made. If the aircrew has not taken over the control of the intercept and the intercept has not reached the attack phase when this point is reached, the AIC should make the conversion to a stern attack without hesitation.

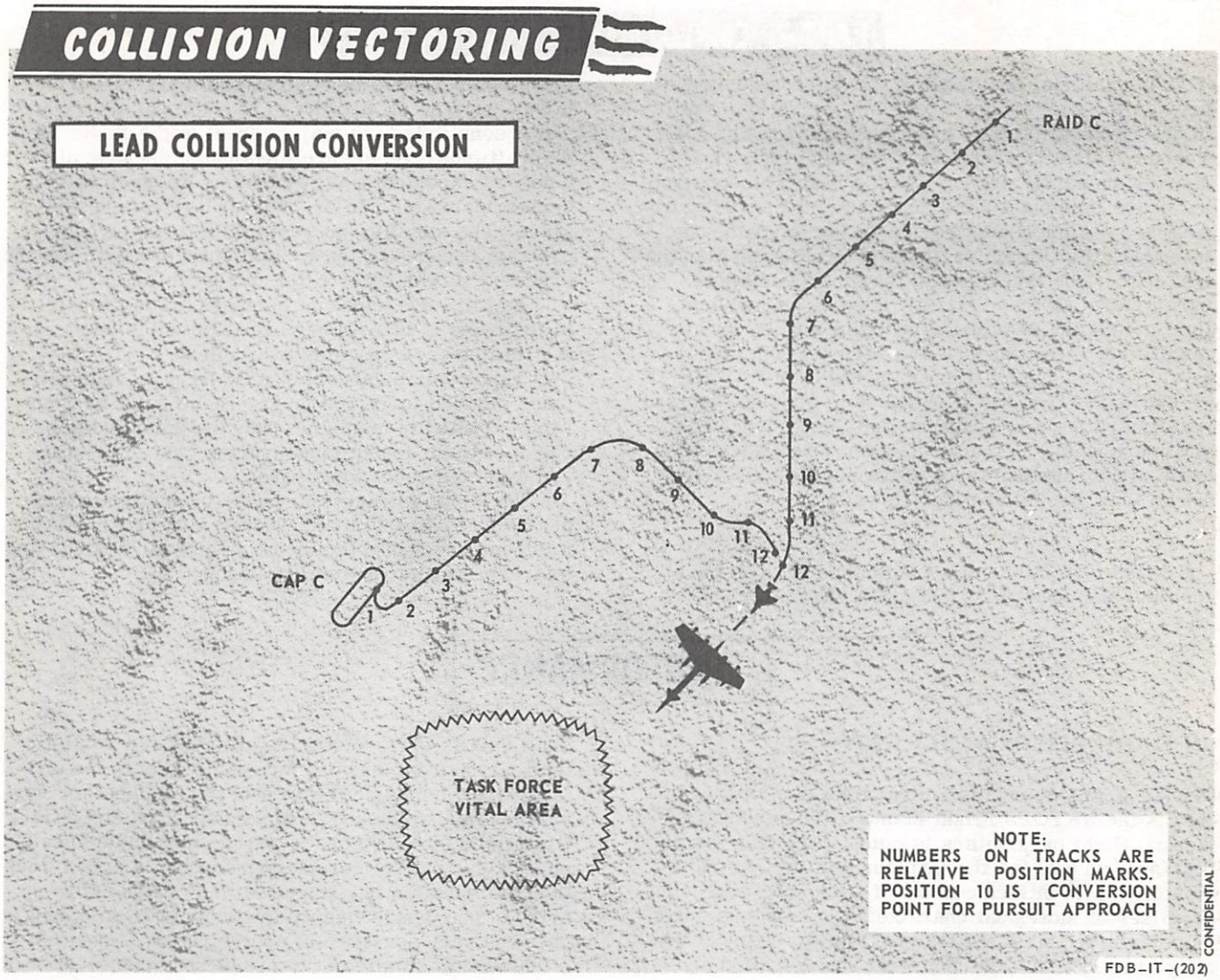

COLLISION VECTORING
LEAD COLLISION CONVERSION
RAID C
CAP C
TASK FORCE
VITAL AREA
NOTE:
NUMBERS ON TRACKS ARE RELATIVE POSITION MARKS. POSITION 10 IS CONVERSION POINT FOR PURSUIT APPROACH
FDB-IT-(202)
CONFIDENTIAL

Figure 3-5 (C)

PART 2 EMPLOYMENT CONSIDERATIONS

(C) The material contained in this part is designed to provide the commander with some yardstick to utilize in determining the best ways of employing the F-4 weapon system to accomplish his objectives, and to provide squadron aircrews with a firmer understanding of the important tactical parameters of task force defense. An intelligent review of the important factors that affect fighter stationing should consider the task force, the threats, and the aircraft tactical parameters. If these factors are well understood, the final choice of fighter stationing will be greatly simplified. A comprehensive review of enemy air-to-air weapon capabilities is available in NAVAIR 01-245FDB-1T(A) and is intended to provide digested, readily available intelligence data for squadron and staff personnel. In brief, the enemy now poses four basic air-to-surface threats against the task force. These four threats are as follows:

a. Mass formations of subsonic bombers flying at medium altitudes of 20,000 to 45,000 feet. Most of these bombers will be equipped with air-to-surface missiles. The probability of this threat is very high and it constitutes the major threat to the fleet. Medium altitude bombers are formidable because of their number, expected heavy screening by electronic countermeasures (ECM), and air-to-surface missiles. The missiles present a difficult intercept problem because of their rapid change in altitude and expected screening by ECM and deception.

b. Low altitude subsonic bombers. The probability of their use is high. They are formidable because of the limited early warning available.

c. Supersonic bombers or ASM flying at high altitudes (45,000 to 55,000 feet). These raids are currently limited in number. They are formidable because of their speed, maneuvering characteristics, and expected countermeasures.

d. Very high altitude snoopers, probably subsonic at 55,000 to 70,000 feet. These raids present a difficult intercept problem because of their altitude and intercept weapon system limitations.

PERFORMANCE

(U) FLIGHT PERFORMANCE DATA

(U) The prime source for most flight performance data is the NATOPS Flight Manual. The question of tactical flight parameters is much more than simply how fast, or how far the airplane will go. It fundamentally is an intricate maze of trade-offs and compromises of individual characteristics such as speed vs configuration. If the trade-offs have been determined wisely, then the resultant configuration and flight profile will be balanced to fit the mission, and tailored to meet the specific threats. If the decision is poor, then the weapon system will be badly unbalanced. When this happens, one characteristic, such as high speed, may be overemphasized at the expense of another, such as cycle time or configuration. The practical result is that the weapon system is either degraded to the weakest characteristic, or is tailored to meet nonexistent rather than real threats.

(U) TACTICAL FLIGHT PERFORMANCE

(U) The succeeding articles will detail the tactical significance of this airplane as a flexible workhorse, rather than the maximum capability of the airplane as a racehorse. A brief tabular summary of the basic configurations of the airplane is presented in figure 3-6.

(U) Speed

NEW

(U) The most spectacular performance parameter of the airplane is speed. The airplane can exceed Mach 1.4 comfortably in low external drag configurations. Speed, because of its obvious advantages, is frequently used as the primary criterion of tactical capability. However, high speed employment of the aircraft entails very serious limitations in a realistic tactical environment. Figure 3-7 presents the altitude-Mach number envelopes of the airplane for several configurations. The important characteristic illustrated by the figure is not the maximum speeds obtainable, but the severe degradation is speed when the configuration is changed to that of a heavily armed, long range weapon system. In other words, speed is very sensitive to configuration. Speed is often used in an attempt to overcome other weaknesses such as poor vectoring control, or late CAP commitment caused by inadequate early warning or slow CIC/AIC reaction time. However, in doing so, it frequently is not realized that once the airplane has been accelerated to supersonic speed, it has usually lost its flexibility. Figure 3-8 illustrates the typical quantity of fuel required to accelerate a moderately loaded aircraft. The important conclusion to draw from this figure is that once accelerated, the airplane is literally in irons. To remain at supersonic speed requires 500 to 1000 pounds of fuel per minute. If the intercept is delayed or called off because of raid feint, CIC/AIC error, or friendly identification, the interceptor must return to an endurance profile. When the power is reduced the airplane rapidly decelerates to subsonic speed. Almost all the fuel energy expended to attain supersonic speed is thereby dissipated. This is also illustrated in figure 3-8. Normally, one acceleration to a high supersonic speed will consume most of the combat fuel package. The use of speed as the primary tactical parameter for every intercept renders the weapon system highly vulnerable to raid feints and false alarms. Speed is usually valuable only when the requirement to match a high speed raid, or to cover a distance rapidly, overrides the loss of CAP flexibility.

PERFORMANCE CONFIGURATION SUMMARY

Configuration	Take-Off GR. WT. (JP-5) Lbs.	(1) Combat GR. WT. Lbs.	Empty Wt. Lbs.	Landing Fuel 34,000 GR. WT. Lbs.	(2) Climb - Military (Take-Off WT. to Combat Ceiling) T / F / D	(2) (3) Climb - Maximum (Take-Off WT. to Combat Ceiling) T / F / D
1. (4) SPARROW III	43,532	38,071	29,884	4,116	9.8 / 1,635/86	6.1 / 2,860/54
2. " " " +(1) 600 gal. CL tank	47,931	40,838	30,203	3,797	10.4 / 1,885/88	6.3 / 3,125/57
3. " " " +(2) 370's	49,213	41,739	30,533	3,467	10.5 / 1,910/88	5.4 / 3,200/57
4. " " " +(1) 600 + (2) 370's	53,612	44,512	30,852	3,148	11.1 / 2,170/93	6.6 / 3,470/59
5. " " " +(4) SIDEWINDERS	44,902	39,441	31,254	2,746	10.8 / 1,883/90	6.5 / 3,040/57
6. " " " +(4) SIDEWINDERS (1) 600	49,301	42,208	31,573	2,427	11.6 / 2,185/95	6.7 / 3,485/59
7. " " " +(4) SIDEWINDERS (2) 370's	50,583	43,109	31,903	2,097	11.7 / 2,240/96	6.8 / 3,550/60
8. " " " +(4) SIDEWINDERS (1) 600 (2) 370's	54,982	45,876	32,222	1,778	12.6 / 2,610/103	7.0 / 3,700/62

(2) Combat Ceiling Military/Maximum Subsonic/Supersonic Feet / Feet	(4) V_{max} 36089 FT. Military/Maximum IMN / IMN	(4) (5) Acceleration V_{max} Max. Power T / F / D	(6) Range Opt. Alt. T / D	Range Sea Lvl. T / D	Endurance Opt. Alt. T	Endurance Sea Lvl. T	
42,850 / 57,110	.99 / 2.26	6.8 / 6,400/113	114/ 952	83/458	124 /	103	1.
40,770 / 51,250	.97 / 1.8	4.7 / 3,285/58	155/1,284	115/629	164 /	140	2.
40,300 / 48,400	.96 / 1.6	4.6 / 3,186/55	164/1,355	121/670	172 /	148	3.
38,400 / 39,730	.96 / 1.6	5.2 / 3,350/63	196/1,622	148/822	206 /	178	4.
40,900 / 52,500	.96 / 2.05	6.9 / 6,500/105	101/831	78/417	109 /	96	5.
38,850 / 44,350	.95 / 1.8	9.4 / 7,520/127	137/1,122	108/578	146 /	130	6.
38,430 / 39,550	.94 / 1.6	10.3 / 7,200/127	146/1,193	114/619	162 /	135	7.
36,450 / 41,400	.92 / 1.05	— — —	172/1,403	140/750	188 /	161	8.

NOTES:
1. Combat Gross Weight = 60 percent initial fuel remaining.
2. Combat Ceiling = 500 FPM maximum rate of climb. T = time in minutes, F = fuel in pounds, D = distance in nautical miles.
3. Maximum power climb subsonic. Ceilings higher for supersonic climb.
4. V_{max} and acceleration to V_{max} assumes external tanks retained and speed restrictions observed (1.8 IMN, C_L; 1.6 IMN W.T.).
5. Acceleration, at 36,089 feet, commences from maximum endurance speed, at combat gross weight.
6. Total time (distance) includes military take-off, climb and cruise, allowing 500 pounds for taxi, etc., 4,000 pound reserve.
7. Standard day conditions.
8. Weights computed for AIM 7-E and AIM 9-D Missiles

UNCLASSIFIED

FDB-1T-203

Figure 3-6 (U)

LEVEL PERFORMANCE VERSUS CONFIGURATION

REMARKS
ENGINE(S): (2) J79-GE-8
ICAO STANDARD DAY

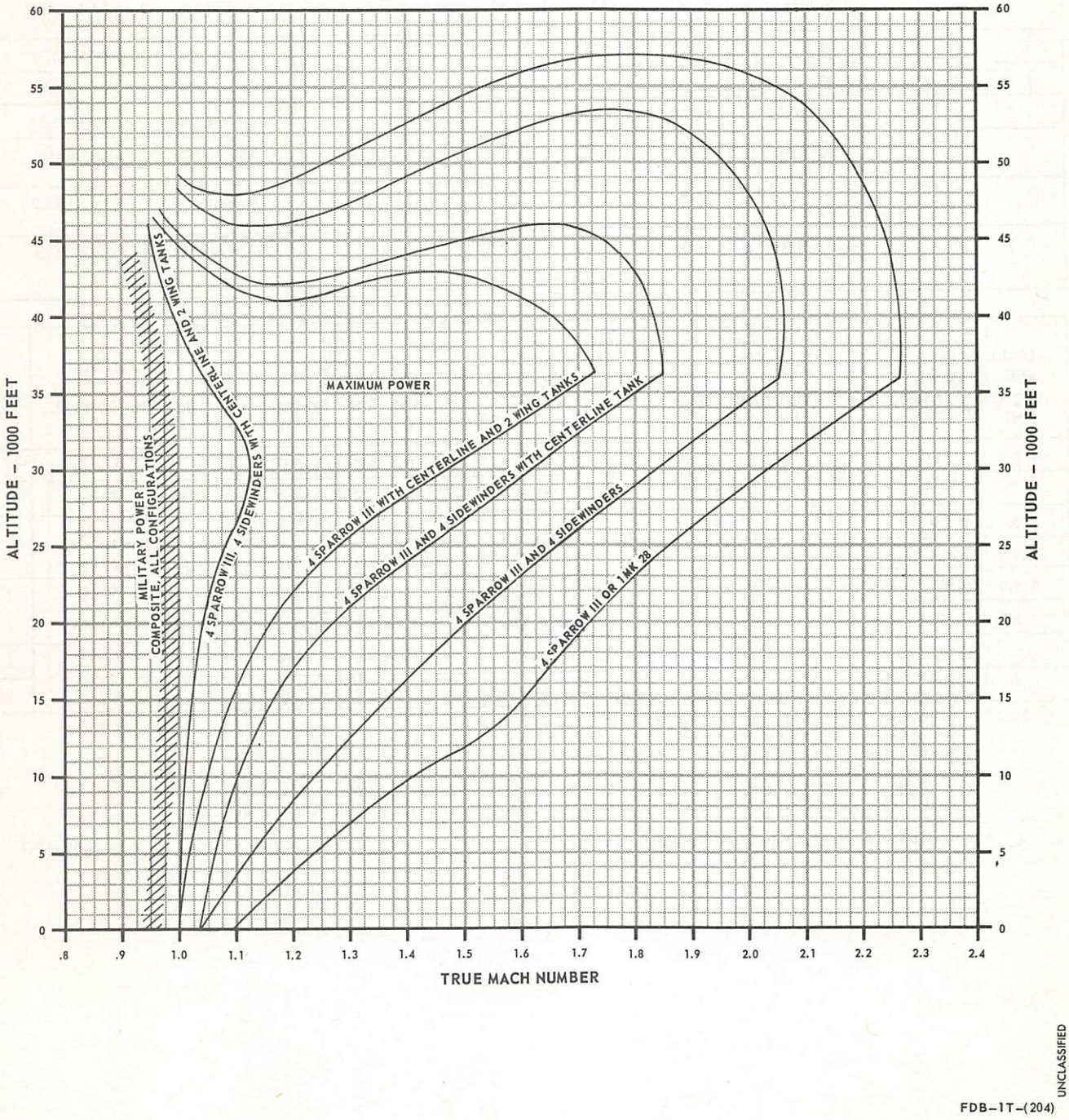


Figure 3-7 (U)

ENERGY CONVERSION OF SPEED AND FUEL

AIRPLANE CONFIGURATION
(4) SPARROW III, (4) SIDEWINDERS

REMARKS
ENGINE(S): (2) J79-GE-8
ICAO STANDARD DAY

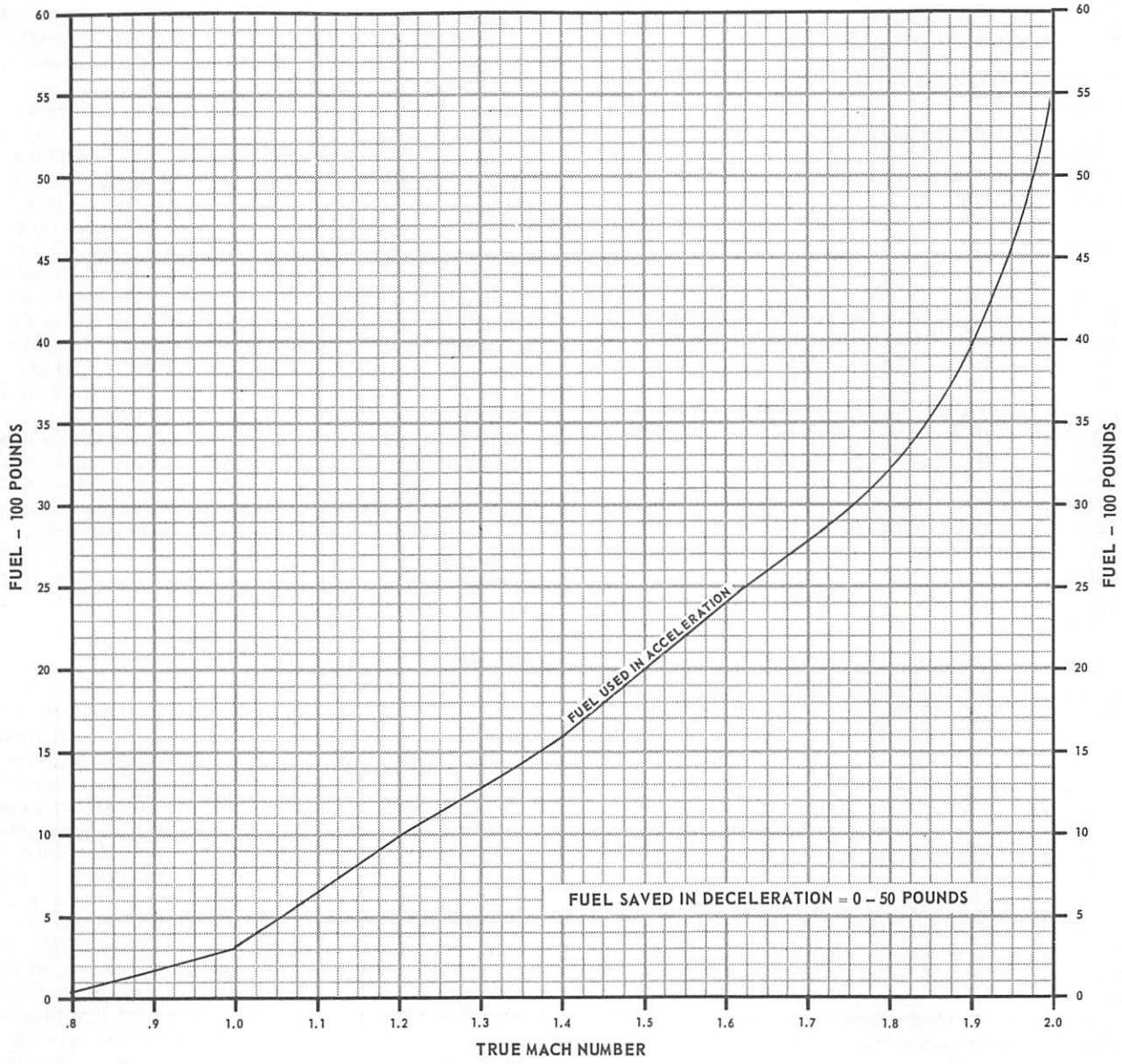


Figure 3-8 (U)

(U) Climb

(U) The second important flight characteristic, climb capability, is also created by the tremendous thrust of the airplane. However, it climbs only moderately faster to medium altitudes than the F-8 or the T-38. Figure 3-9 presents typical times-to-climb for several configurations. As noted in the discussion of speed, the tactically useful lesson to be drawn from this figure is not the rapid time-to-climb to 35,000 feet, but the tactically insignificant differences between configurations. The fuel-to-climb to 35,000 feet is about 2000 pounds in all cases. The recovery of fuel energy, if the intercept is called off for any reason, is relatively good as shown in figure 3-10. The airplane can glide back to low altitude and regain about 50 percent of the fuel energy expended to climb. An important characteristic of climb is that the aircrew can control the full performance in VFR or IFR conditions. In a tactical sense the use of climb as a basic parameter does not jeopardize the flexibility of the weapon system.

(U) Descent

(U) The third performance characteristic is descent. This airplane offers little improvement over contemporary airplanes in time-to-descend. Under day VFR conditions, a descent from 35,000 feet to 500 feet can be made in about 2 minutes; however, in darkness or adverse weather the time required may double. In order for the interceptor to have a 30 mile detection opportunity after the descent, the decision to commit the interceptor to low altitude must be time limited. The tactical importance is not the time-to-descend, but the fact that the radar may not be as effective until the airplane is even with, or below the altitude of the bogey.

(U) Range

(U) In order to establish a tactical altitude for the aircraft, the specific range characteristics, from the charts in the NATOPS Manual, must also be examined. The charts reveal that:

a. Supersonic specific range is very low below 35,000 feet. (20-25 NM/1000 pounds at 35,000 feet.)
b. Supersonic specific range is markedly degraded by configuration (two tanks reduce specific range 20 percent).
c. Supersonic specific range is relatively unaffected by moderate speed changes.
d. Transonic (550 KTAS) specific range is relatively good at 20,000 feet (62-67 NM/1000 pounds at 20,000 feet).
e. Transonic specific range is only moderately degraded by configuration (two tanks reduce specific range eight percent).
f. Transonic specific range is sensitive to speeds above 550 KTAS.

The most flexible working altitude and airspeed for the airplane is 20-25,000 feet at 500-550 KTAS. This provides very high maneuverability, with good specific ranges and transonic speeds, over a wide spread of configurations. (Note that Mach 1.0 at 36,000 feet is 570 KTAS.) The selection of a supersonic altitude and airspeed rests on the configuration and the characteristic desired. When a straight high speed dash is desired, the highest altitude attainable should be used. When the airplane must maneuver for position, attack or reattack, then 35,000 feet offers the best compromise. Mach number can be varied from 1.2-1.6 over this altitude band without seriously changing the specific range or rate-of-turn.

(U) Endurance

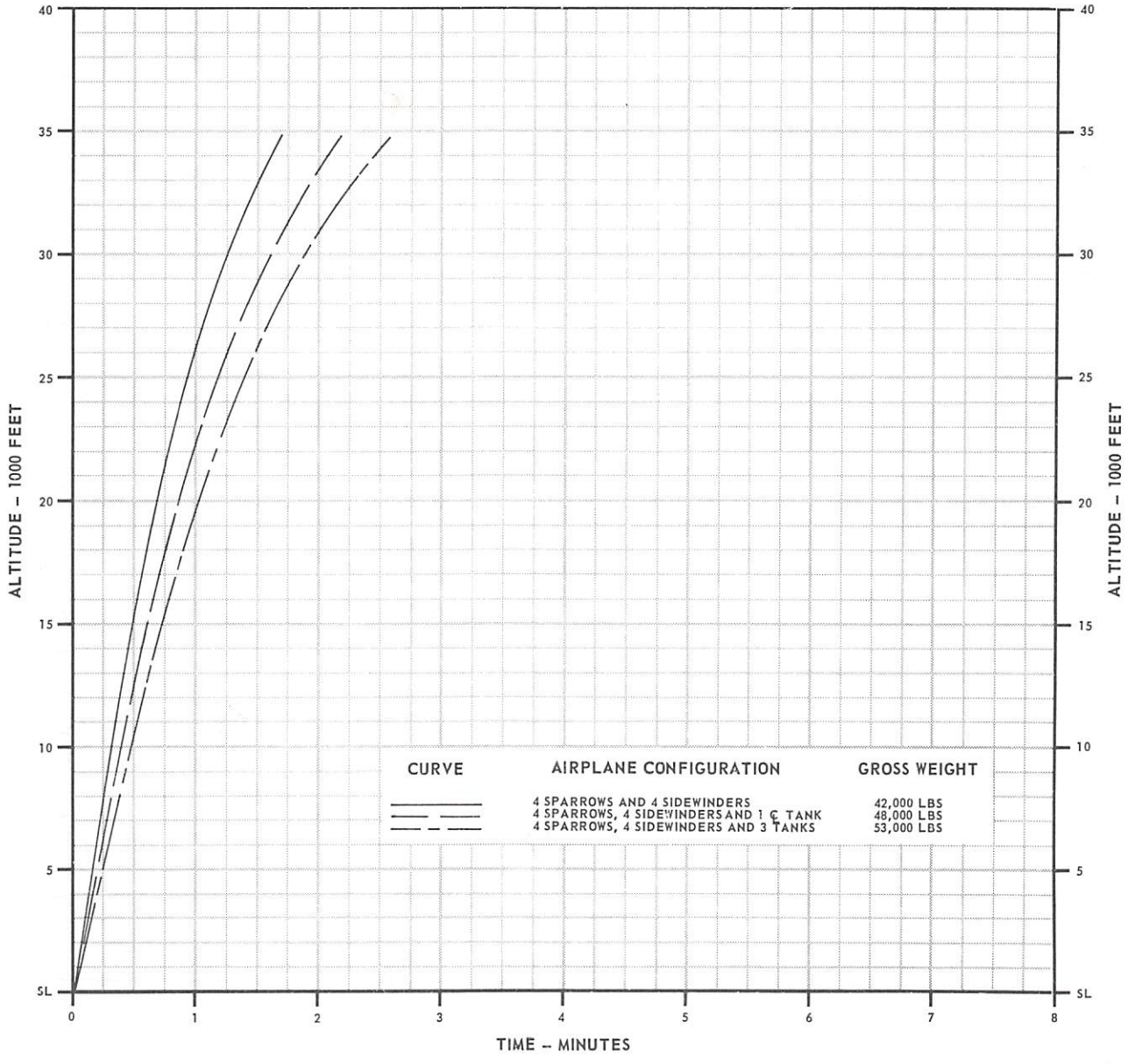
(U) Endurance is an important tactical parameter. Increased endurance means increased cycle time. The tactically important variable which must be related to endurance is altitude. This relationship is presented in figure 3-11. The important conclusion to draw from this figure is not that the optimum endurance altitude is about 35,000 feet, but that there is only a slight degradation at all altitudes below 35,000 feet. This means that if it is tactically advantageous, the selection of a CAP altitude can normally be made without serious consideration of the best endurance altitude. It should be noted that endurance flight is obtained at relatively constant IAS, while the TAS and Mach number change with altitude. This fact is important for three reasons. First, the spread in the maximum range speed and the maximum endurance speed is decreased with altitude. This is of importance where planning a run-out to a long range CAP station, where the on-station time is reduced by both cycle time and transit time. Second, the CAP station turning diameter for an economical bank angle is increased. Third, the time to turn at an economical bank angle is increased 60 percent between sea level and 35,000 feet. The economical bank angle is a compromise between resultant radius of turn, and increased fuel consumption resulting from the greater thrust required in banked turn.

(U) Ordnance Configuration

(U) The air-to-air ordnance configuration of the airplane can be widely varied. At present, the primary weapon is the AIM-7 (Sparrow III) missile and the secondary weapon is the AIM-9 (Sidewinder) missile. The minimum air-to-air loading is one AIM-7 missile in a fuselage station. The maximum loading is four AIM-7 and four AIM-9 missiles. The selection of the correct ordnance configuration is dependent upon the nature of the threat, the effectiveness of the missile at intercept conditions, the weight limitations of the airplane, and the number of missiles available. In regard to ordnance load selection, the nature of the threat is made up of the number of targets each interceptor is expected to engage, the raid flight profile, and the vulnerability of the raid to the missile warhead. If the expected ratio of target (including air-to-surface missiles and decoys) to interceptors is high, the interceptor should carry the maximum load of eight missiles. If the profile of the expected raid is very high and/or supersonic, the drag imposed by the wing mounted AIM-9 missiles may be too great to permit the aircraft to accelerate for attack. (Of course, the missiles can be jettisoned, if necessary and logistic considerations permit.) Some targets

MAXIMUM POWER CLIMB

REMARKS
ENGINE(S): (2) J79-GE-8
ICAO STANDARD DAY



UNCLASSIFIED

FDB-1T-(206)

Figure 3-9 (U)

ENERGY CONVERSION OF ALTITUDE AND FUEL

AIRPLANE CONFIGURATION
(4) SPARROW III, (4) SIDEWINDERS
PLUS (1) CENTERLINE TANK

REMARKS
ENGINE(S): (2) J79-GE-8
ICAO STANDARD DAY

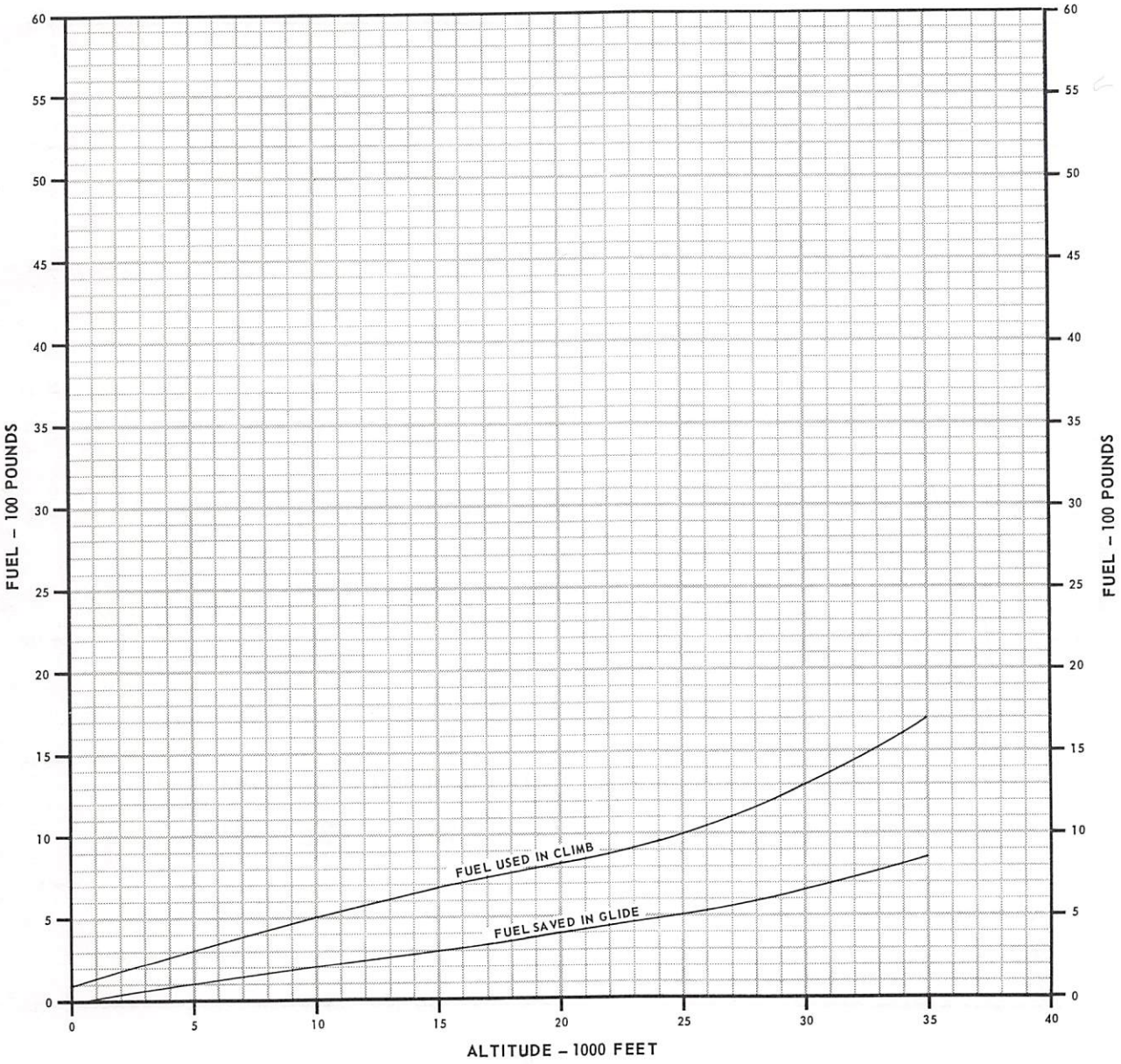
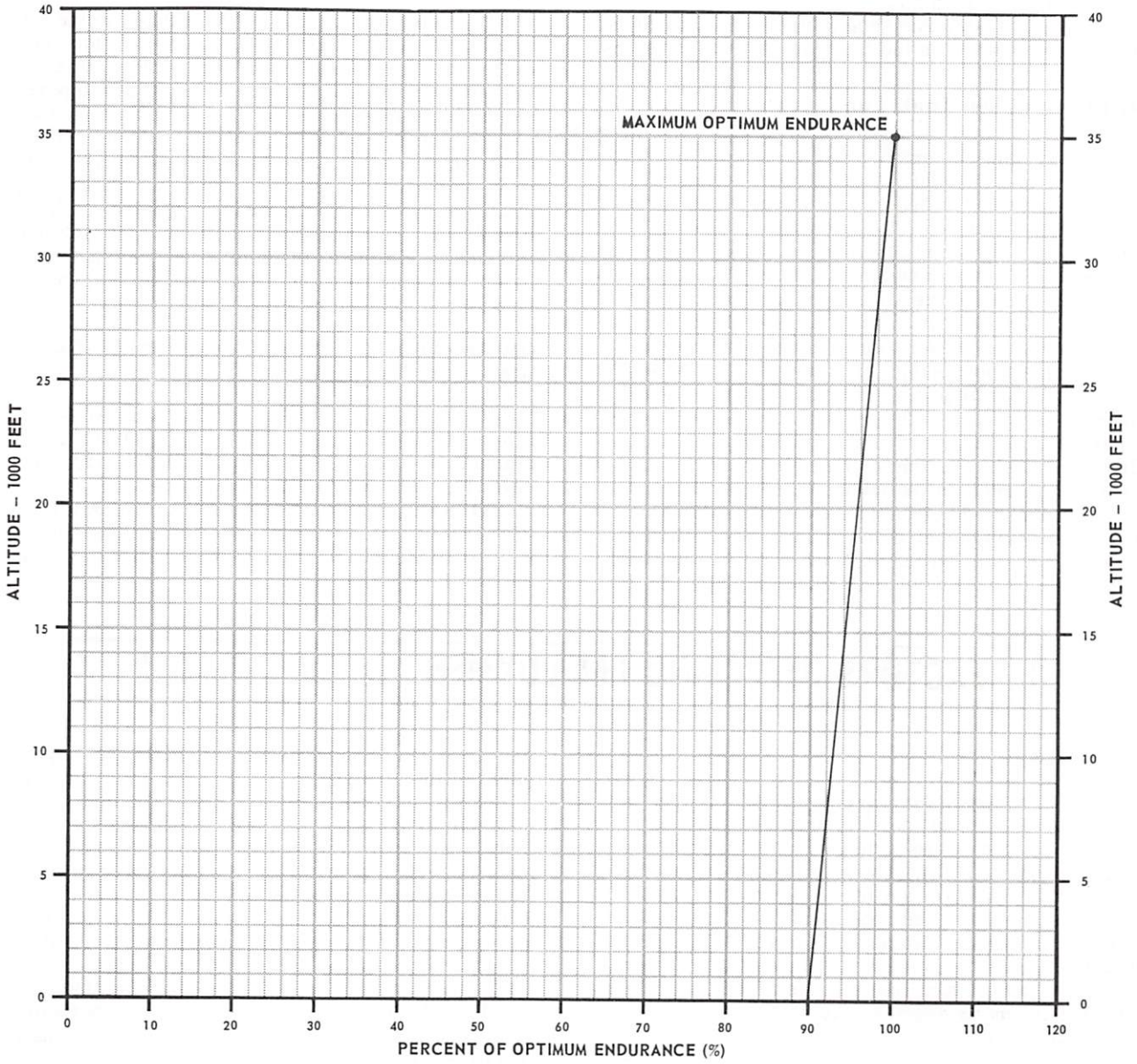


Figure 3-10 (U)

ENDURANCE VERSUS ALTITUDE

REMARKS
ENGINE(S): (2) J79-GE-8
ICAO STANDARD DAY



UNCLASSIFIED

FDB-1T-(208)

Figure 3-11 (U)

are quite vulnerable to the AIM-7 or the AIM-9 missiles, others are relatively invulnerable. The expected vulnerability of the raids determine how many missiles should be expended on each target if an opportunity to assess results of each missile fired is not provided. The effectiveness of the missile at intercept conditions must be considered. The weather, altitude and target signature are the primary factors that affect the missile selection. Section I discusses in detail the tactical limitation of each missile. A compromise missile loading for the airplane is two AIM-7 and two AIM-9 missiles. This provides a nominal attack and reattack capability against most current threats, with an acceptable landing weight. However, the task force should be prepared to adjust this loading upward as the tactical situation develops.

(U) External Fuel Tank Configuration

(U) The airplane is equipped to carry two 370-gallon wing tanks and one 600-gallon centerline tank. The tanks are unusual in that their tactical characteristics vary widely. The two 370-gallon wing tanks add about 650 pounds to the empty landing weight and 5700 pounds to the take-off weight. This increases the subsonic cycle time of the airplane about 30-45 minutes. They have little effect on subsonic speed and climb performance. However, they degrade supersonic performance appreciably. The use of the wing tanks with two AIM-9 missiles, mounted on the outboard sides of the wing missile pylons, substantially lowers supersonic performance above 1.5 Mach. This can be alleviated to some extent by carrying only two AIM-9 missiles mounted on the inboard sides of the pylons. The wing tanks do not interfere with the AIM-7 or AIM-9 missiles mounted on wing stations. Most maintenance work on the airplane can be conducted without removing the wing tanks. The 600-gallon fuselage centerline tanks adds about 320 pounds to the empty landing weight and 4400 pounds to the takeoff weight. It increases the subsonic cycle time of the airplane about 30-45 minutes. It has little effect on subsonic or supersonic performance. The two forward AIM-7 fuselage stations cannot be fired when the 600-gallon tank is carried. The centerline tank does not interfere with wing loaded AIM-9. The centerline tank frequently must be removed to permit maintenance work in the fuselage. This adds considerably to maintenance time and increases the incidence of fuel transfer failures. The combination of the two 370-gallon wing tanks and the one 600-gallon centerline tank adds about 970 pounds to the empty landing weight and 10,000 pounds to the takeoff weight. They add about 60-75 minutes to the subsonic cycle time. The mounting of three tanks and eight missiles degrades subsonic speed and climb performance negligibly. However, this combination severely reduces the supersonic capability of the airplane to about Mach 1.1. The number of tanks of the right type, in supply, is also a factor to consider. In general, the two 370-gallon tanks or one 600-gallon external tank appear more suitable for most tactical missions. However, the additional cycle time offered by the three tank configuration should be seriously considered for long range CAPs.

(U) AN/APQ-72, AN/APG-59, AIM-7 AND AIM-9 CAPABILITIES

(U) The AN/APQ-72 radar, AIM-7, and AIM-9 missiles are discussed in detail in the NATOPS Flight Manual Supplement, NAVAIR 01-245FDB-1A. The AN/APQ-59 radar is discussed in detail in the NATOPS Flight Manual Supplement, NAVAIR 01-245FDD-1A. Radar and missile limitations and capabilities in various environments are discussed in section I of this publication.

FACTORS AFFECTING EMPLOYMENT OF CAP OR DLI

(U) GENERAL

(C) The F-4 weapon system can be employed in the air-to-air defense of the vital area by two basic methods. It can be flown on CAP, or maintained on ready status as a DLI. The most important advantages of the CAP are that it accelerates the task force reaction time and can extend the air-to-air defensive envelope. However, a sustained CAP will usually exhaust the reserve airplanes within a few hours and thus reduce the total task force armament. The DLI generally shortens the defensive envelope but maintains a higher sustained total readiness. Regardless of the employment, the aircraft should normally carry the maximum fuel and missiles consistent with safety. In practice it may be advantageous to mix, merge, or vary the employment methods as befits the tactical situation. This article presents the important considerations affecting the employment of the airplane in a task force environment. However, the principles are also valid and are applicable to the problems associated with short-based defenses. The primary factors affecting the selection of CAP or DLI defense are the task force mission, the enemy threat, the task force early warning capability and reaction time, the other task force defenses (such as SAM ships and allied short-based support), the number of interceptors available and rate of launch, the weather, the EMCON doctrine, and the logistic considerations. Many of these factors are interrelated and frequently in conflict. Their relative importance varies with each situation. A brief discussion of the independent effect of each factor on the selection of CAP vs DLI defenses follows.

(U) MISSION

(C) The mission of the task force usually generates the requirement for air-to-air defense. The mission is called out by higher command and is beyond the scope of this book. However, the mission may place several restraints on the selection of CAP or DLI defenses. For example, the nature of the mission dictates the type of conflict, the required movement of PIM (point of intended movement), and the extent of deck preparations for launching the attack airplanes. The basic types of conflict are general (atomic) war and limited (conventional) war. The latter includes the spectrum from Lebanon patrols to World War II-type full scale opposition. An important difference between the general and the limited wars is the weapon system lethality of the enemy air-to-surface threat. When atomic weapons (free-fall or ASM) are employed, the lethality is presumed to be very high. At the same time the number of atomic weapons directed at a single target will normally be small. The problem usually imposed on the task force is to obtain a high percentage of kills as fast as possible until the carrier attack is launched. Under these conditions, the CAP should be of more value than the DLI. The limited war is characterized by the opposite situation. The enemy weapon system lethality is low, while the delivery methods probably include saturation raids. In this case the deck launched interceptor should offer the greatest overall protection. If the early warning time is sufficient to permit assignment, launch, and deployment of the DLI, a large number of the interceptors may be brought to bear on sustained and saturating raids.

(U) ENEMY THREAT

(C) The nature of the enemy threat to the task force has a vital bearing on the decision to employ CAP or DLI. The threat can come from the subsurface, surface, or air, or any combination of these. The subsurface threats are normally submarines and mines. The potential enemy has large numbers of each and is well versed in their employment. The undersea weapons constitute a serious threat in limited war because of their effectiveness with conventional warheads and because the task force mission may require close-in operations. It is quite possible for a situation to develop wherein the task force has little air, but severe subsurface opposition. The major defense of the attack carrier task force against subsurface threats is mobility. The effect of CAP cycle time on reducing mobility was discussed in the preceding paragraphs. The surface threats are normally conventional and surface-to-surface (SSM) missile-armed combatant ships and motor-torpedo boats. In order to counter these threats, the carrier must stand off until its attack planes or supporting forces can destroy them. In order to stand off, the carrier requires mobility which may be reduced by the use of CAP. The air threats are conventional, nuclear, biological, and chemical warheads delivered by airplanes and/or guided missiles. The threat profiles, lethality and vulnerability to task force defenses are a primary factor in determining the use of CAP or DLI. In general the CAP is best against threats that are few in number, close-in when detected, or that utilize long range stand-off weapons. The DLI is superior when the raids are sustained or numerous, distant when detected, or employ close-in or free-fall weapons. A detailed summary of current enemy air threats is available and should be supplemented with the latest intelligence order of battle, and other information, when entering an operating area.

(U) EARLY WARNING RADIUS

(C) The task force early warning radius is one of the most important factors affecting the choice of CAP or DLI. Early warning means time to evaluate, communicate, decide and act. The time required to do this is the task force reaction time. Every minute required to complete the cycle of reaction is equivalent to 8 to 15 miles of early warning range (depending on raid speed). It is most important to note that the early warning radius is highly variable and difficult to measure because it is changed by atmospheric conditions; relative stationing of friendly ships, air and shore sites; electronic status of the individual sites; and the signature, position, and altitude of the threat. Generally speaking, a long early warning radius permits the use of DLI, while a short radius negates their practical value.

(U) OTHER TASK FORCE DEFENSES

(C) The other task force air defenses must be considered in stationing CAP or DLI. The other air defenses include supporting ship and shore-based interceptors and surface-to-air missiles. The supporting activities may act to supplement the overall task force defenses, or to deny the use of certain approach quadrants to the enemy. The SAMs are usually designed to counter either raids very close in, near the radar horizon, or raids farther out at higher altitudes. The present fleet doctrine is to avoid overlapping the interceptor zones of defense with SAM zones. The introduction of long range (50 to 100 NM) SAMs such as TALOS may extend the SAM zone out 50 to 100 miles from the vital area of the task force. When the SAM zone is extended to such long ranges, the DLI is unable to reach the raid beyond the SAM perimeter, and the effectiveness of the interceptor in providing wide angular coverage for long on-station cycle times is seriously degraded. A promising solution to the conflict of SAM zones vs CAP station is to position the interceptors close in, below the SAM horizon. At the same time, the SAM batteries should be prevented from engaging the interceptors as they proceed outbound toward an incoming raid. This technique should permit full use of SAMs and interceptors against higher raids, and full use of the interceptors against low raids.

(U) NUMBER OF CAP INTERCEPTORS

(C) The number of interceptors available is a fundamental consideration in the decision to use CAP or DLI. The number available is dependent on the total number on board, the average repair time, the cycle time, and the length of time the CAP station will be maintained. Present policy is to have two squadrons of F-4 aircraft on each large carrier. These make up a total of 24 to 28 interceptors. The ship loading

(C)
can be changed to meet a tactical situation. However, increasing the fighter complement reduces the attack capability of the task force. The average repair time is the average time it takes for the airplanes not out of commission for long periods of time (such as checks and prolonged AOCP) to be again readied for flight. If the average repair time is observed during typical task force operations it will provide a simple, rough index of all of the local factors such as deck spots and logistic bottlenecks, which retard maintenance work. When the average repair time is matched to the cycle time, an estimate can be made of the number of sustained CAP stations which can be maintained by each squadron. With normal logistics support, each squadron should be able to maintain two CAPs on station indefinitely. The cycle time of a CAP or DLI should provide enough fuel to conduct the flight, complete one or more intercepts and have sufficient fuel remaining to delay recovery until the raid has departed the vital area. In order to accomplish this, the cycle time should be based on a maximum landing weight plus an expendable combat fuel package of several thousand pounds. The number of CAP stations can be increased for short periods of time by utilizing the airplanes more rapidly than they can be repaired. This may be of value in providing protection when the task force is particularly vulnerable, as during dawn and dusk, replenishment, large scale nuclear attack strike loading, or when supporting defenses are temporarily not available.

(U) DECK LAUNCH INTERVAL

(C) The time required to launch the first deck launched interceptor and the rate of launch of the succeeding DLIs are important factors to consider. The time to complete the first launch can be a large share of the task force reaction time. It is affected by the condition of readiness of the aircrew, flight deck crew, and the turn into the wind required to meet the launch wind requirement. The rate of launch of the succeeding DLIs determines how many interceptors will engage the raid. It is primarily a function of the reserve airplanes available and the capability of the ship to start and launch them. Launch rate may be slowed appreciably at night and/or in poor weather conditions.

(U) WEATHER AND EMCON

(U) Adverse weather may render carrier air operations and the use of CAP difficult or impossible. The operation of a CAP during severe conditions of EMCON may be of little aid because of the absence of early warning. In addition, it may jeopardize the tactical value of the EMCON deception.

(U) LOGISTICS

(U) The amount of fuel consumed by a sustained CAP may be of importance in the decision to employ either CAP or DLI. The airplane averages about 1000 gallons per hour of flight. The use of a sustained three-plane CAP for 72 hours would require over 200,000 gallons of fuel.

(U) ESTIMATING CAP/DLI CAPABILITY

(U) The factors of task force reaction time, raid speed, SAM zone radius, CAP station, bomb release line, early warning, deck launch rate, and reattack rate all have one common denominator. They modify the time available for a given interceptor to engage the raid. This determines the number of DLIs that can engage the raid and the total number of attacks and reattacks that a CAP or DLI can conduct against the raid. The computation of the relative values of these factors is a difficult task.

CAP STATIONING

(U) GENERAL

(C) CAPs are stationed in defense of a task force for several reasons. They provide the most rapid air-to-air engagement of enemy raids, identify incoming unknowns, and augment the early warning information. Fundamentally, there are five general CAP station locations. They are low-near, low-far, high-near, high-far, and long range. The selection of the correct CAP stations to fit the tactical situation is dependent upon several important factors. They are:

a. The nature of the threat.
b. The area to be defended.
c. The supporting air defense weapons.
d. The number of interceptors assigned and their cycle time.
e. The presence and effect of trapping layers on the radar capability of the interceptor.
f. The extent of the early warning and communication perimeters and the EMCON condition. The following articles will discuss the effect of these factors on the five CAP stations.

(U) LOW-NEAR CAP STATIONING

(C) The low-near CAP station is defined as being close to, or in the vital area at an altitude commensurate with the weather, which will permit immediate engagement of low flying raids at co-altitude. The difficulties encountered in detecting low flying attacking aircraft have long been realized. It is assumed that once the position of the task force has been established by the enemy, low level attacks may be expected. The following advantages of low level attacks support this theory:

a. Late or no detection by task force radar (attackers are in sea return and/or below radar horizon).
b. High performance, or extremely well equipped counter-measure attack aircraft are not expected to pose a serious low level threat.

(C) Late, or nondetection of low level raids will degrade or completely negate the effectiveness of SAM missile batteries; therefore, the mission of detecting low level raids will be the responsibility of the AEW aircraft or an AEW station. The responsibility for destroying these raids will rest with the interceptor. The interceptors weapon system gives it a capability of attacking low flying targets, and because of the interceptors excellent performance characteristics, it also retains the capability of attacking medium and high altitude targets. Since the interceptor/air controller team has been proven particularly effective in countering the low level threat, the tactics discussed in the following paragraphs are designed to combine the best features of the interceptor/air controller team concept.

(U) ADVANTAGES OF INTERCEPTOR/AIR CONTROLLER TEAM CONCEPT

(U) In addition to the advantages derived by utilizing a low-near CAP station (refer to CAP Stationing, this section) the following advantages are realized from the interceptor/air controller concept:

a. The interceptor adds significantly to the force AEW coverage (maintains a visual or predetermined CAP pattern in close proximity to the AEW aircraft).
b. Positive, continuous radar tracking and plotting of the CAP is not required (the CAP maintains a station either visually on the AEW aircraft, or in a predetermined geographical pattern).
c. The intercepts can be initiated more expeditiously (close control, or modified broadcast control intercept procedures).
d. The CAP is immediately available to shipboard controller for the intercept procedures.

(U) TEAM COMPONENTS

(C) The normal interceptor/air controller AEW team consists of one E-1B or E-2A on AEW station, with one interceptor assigned under direct control. Commensurate with sustained CAP requirements, aircraft deck loading, and DLI availability, two interceptors may be assigned to one AEW aircraft. The interceptor/air controller team will generally operate in conjunction with, and under the over-all AEW authority of a controlling ship. In this environment, the airborne team is generally charged with the responsibility of protecting against low flying targets within a predesignated sector of the AAW zone. The controlling ship searches for medium and high altitude raids and directs interceptions against these raids. To facilitate air intercept control, the entire team, ship controller, interceptor and air controller aircraft are assigned one UHF frequency.

(U) TEAM STATIONING

(U) The assignment of the E-1B or E-2A, AEW station and the decision to utilize the interceptor/air controller team concept will be made by the force AEW commander.

(U) Air Controller (E-1B) Stationing

(C) Normally the E-1B will be assigned a station 40 to 60 miles from the controlling AEW ship or from the formation center (ZZ). This station facilitates the detection of low flying targets out to approximately 100 miles from the controlling ship or ZZ. The air controller (E-1B) station altitude is dependent upon sea state and atmospheric conditions, including ducting layer, but will normally be at about 1500 feet. The air controller aircraft will normally fly a square pattern using 5 minute legs in order to remain within 7 miles of the assigned station.

(U) Air Controller (E-2A) Stationing

(C) The E-2A should be stationed over the vital area at approximately 36,000 feet, employing basically the same pattern as the E-1B. Refer to figure 3-14. In no case, should the E-2A be stationed closer than 100 miles from land.

(U) Interceptor (F-4) Stationing

(C) To make the most effective utilization of its radar for AEW, the interceptor (F-4) will normally fly a 300 KCAS, 6 minute racetrack pattern, oriented parallel to the threat axis, and within 15 miles of the assigned air controller station (figure 3-12). The interceptor station altitude is also dependent upon weather and sea state conditions, but normally will be flown at 500 feet (day VFR), or 1000 feet (night IFR). Using this time pattern, the interceptor is capable of maintaining station without positive radar control by either the air controller aircraft, or the controlling ship.

(U) COMMUNICATIONS

(C) To reduce the number of radio transmissions, and to ensure that both the air controller aircraft and the controlling ship are aware of the interceptors position at all times, the interceptors make 5 position reports as follows:

1. (CALL SIGN) ON STATION HEADING OUTBOUND - The interceptor has reached its assigned CAP station (generally the same as the air controller aircraft station) and is steady on a track parallel to the station radial at an altitude permitting best radar search, corresponding to weather and sea state conditions.
2. (CALL SIGN) TURNING INBOUND - The interceptor has reached the outer limit of its pattern and is turning to the inbound heading.
3. (CALL SIGN) STEADY INBOUND - The interceptor is steady on the reciprocal of its outbound heading and is proceeding to this heading for 6 minutes.
4. (CALL SIGN) TURNING OUTBOUND - The interceptor has reached the inner limit of its pattern and is turning to the outbound heading in the direction of the threat.
5. (CALL SIGN) STEADY OUTBOUND - The interceptor is steady on the outbound heading and will hold this heading for 6 minutes.

TEAM STATIONING

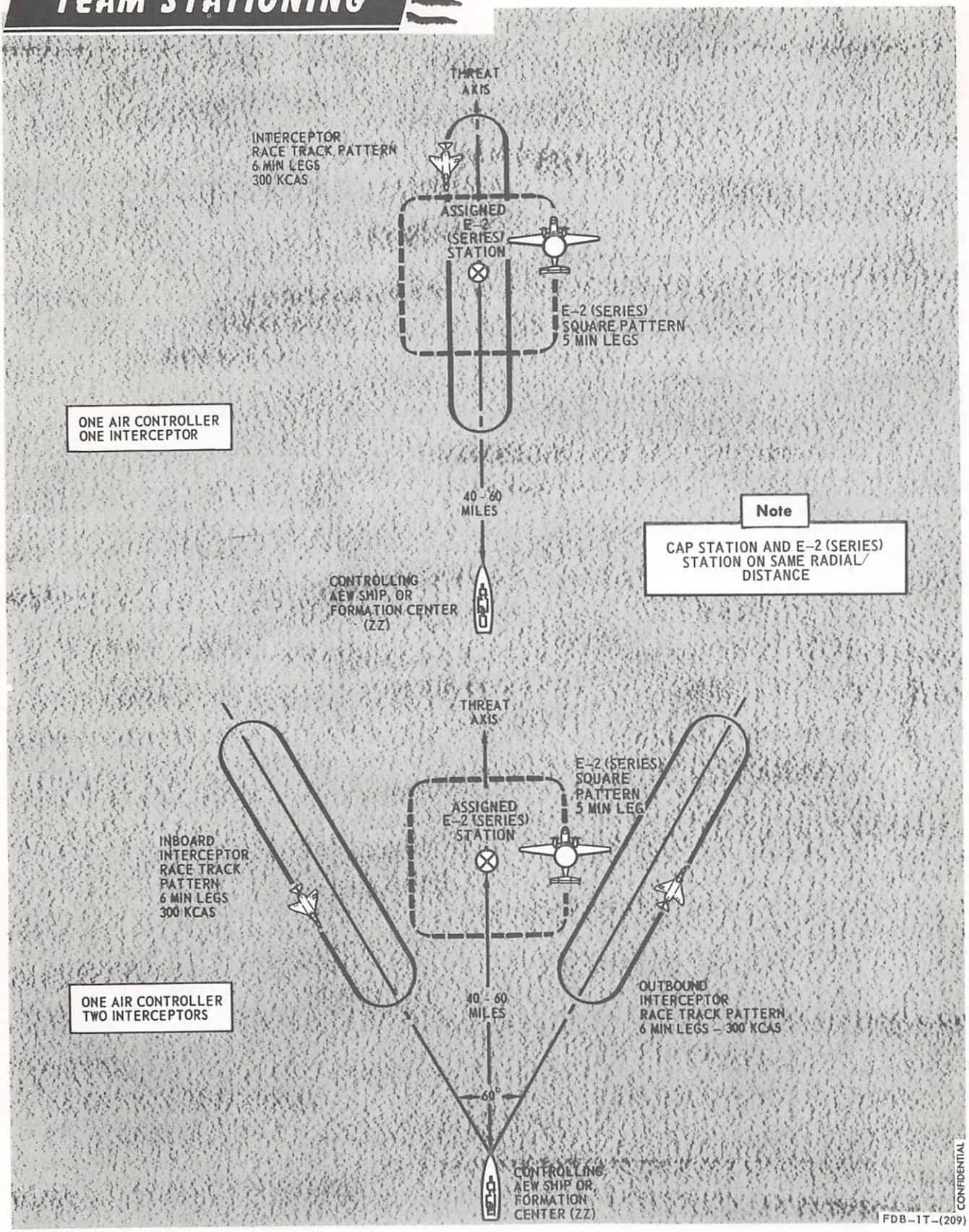


Figure 3-12 (C)

(C) Since it is probable that the controlling ship will not be able to hear these transmissions due to the interceptors station altitude, the air controller aircraft should acknowledge each position report by repeating them verbatum; e.g., (interceptor call sign) STEADY INBOUND, to the controller ship. By noting the time of each transmission, the airborne and surface controller may maintain a continuous plot of interceptor position without the requirement for positive radar control of the interceptor. This type of independent navigation frees all airborne and surface personnel from the requirement of tracking and vectoring the interceptor on station, and thus, provides for more concentration on the primary mission of detecting and intercepting attack aircraft.

(U) NAVIGATION

(U) The interceptors navigation computer (AN/ASN-39 or AN/ASN-39A) will be a valuable aid in station keeping if the geographical coordinates of the CAP station are present in either the target or base counters. Under some circumstances; i.e., a requirement for radio silence, the interceptor may be instructed to station itself visually on the air controller aircraft. This can be accomplished if the interceptor holds in a figure eight pattern, perpendicular to the air controller aircraft track (figure 3-13). This type pattern has advantages in station keeping; however, it does not make the most effective use of the interceptors AEW capabilities, since, the interceptor will be turning almost continuously to maintain visual contact. In addition, continuous turning at low altitude increases fuel consumption appreciably.

(U) TACTICS AND AIR INTERCEPT CONTROL

(C) Although the primary mission of the air controller/interceptor team is the destruction of low flying attack aircraft, it should be emphasized that the interceptor is under the joint control of the airborne controller and ship controller. Therefore, it may become necessary for the surface ship to assume control of the interceptor for attacks on medium or high flying raids. As previously discussed, the interceptor is not tracked on station by either the ship controller or air controller, its approximate location is known from position reports. However, even by knowing the approximate interceptor position, the controller may not be able to achieve immediate, positive, radar identification, due to low CAP altitude or sea return. Therefore, immediate CAP assignment to a raid is mandatory. If the AEW/CAP station is selected as the geographical reference point, the broadcast control intercept procedures may be used. When the CAP climbs to a higher altitude and/or emerges from the sea return, a shift to close control can be made.

(U) Head-On Approach

(C) Lead collision vectoring (part I this section) is applicable to the interception of low altitude raids. Briefly, unless other factors (sea state) preclude it, the controller should attempt to position the interceptor for a head-on approach to the target. This type of an approach, with a subsequent head-on attack, has the following advantages:

a. It establishes the highest closing rate between the interceptor and the raid, thereby, facilitating target detection in clutter and providing for increased AIM-7 capability in a low altitude environment.

b. From a head-on approach and attack, the probability of the target visually sighting the interceptor is decreased, and target evasive action may be more easily countered.

c. If the initial AIM-7 head-on attack fails, the interceptors low altitude maneuverability permits rapid reattack, usually maintaining visual contact with the target.

(U) Beam Approach

(C) There will be instances when the initial relative positions of the target and the interceptor, at the time of raid detection will not permit a head-on attack. In addition, as previously discussed under Low Altitude Targets (section I, part 6), the pulse radar is severely handicapped in the detection and tracking of low flying targets. In these cases the controller should vector the interceptor for a beam approach to a stern AIM-9 attack.

(U) Intercept

(C) upon receiving the initial vector, the interceptor crew should select the lowest safe approach altitude. Experience has shown that an interceptor altitude of 100-200 feet generally provides for sufficient detection to complete the attack. However, after detection the interceptor must climb at least 500 feet before launching missiles. Refer to Low Altitude Targets, section I, part 6. NEW NEW NEW

(U) LOW-FAR CAP STATIONING

(C) The altitude of low-far CAP station is determined by the same criteria as the low-near CAP station. The position of the low-far CAP station varies from just beyond the radar/communications horizon of the task force ships to about one-half of the early warning radius. Advantages and disadvantages of the low-far CAP station are as follows:

a. Advantages.

(1) The airplane can detect and attack low flyers and descending raids at extended range in one quadrant.
(2) Provides one quadrant extended intercept and identification runs against all types of raids.
(3) Permits CAP operation close to and below enemy surveillance radars.
(4) Separates the interceptor and SAM zones vertically and horizontally.
(5) Allows a small CAP station turn radius.

b. Disadvantages.

(1) Requires picket ship or AEW control for high order of effectiveness.
(2) Provides only one-quadrant protection unless a large number of interceptors are airborne.
(3) Requires electronic aids for navigation unless the station is oriented over a geographic point or a picket ship during day VFR.

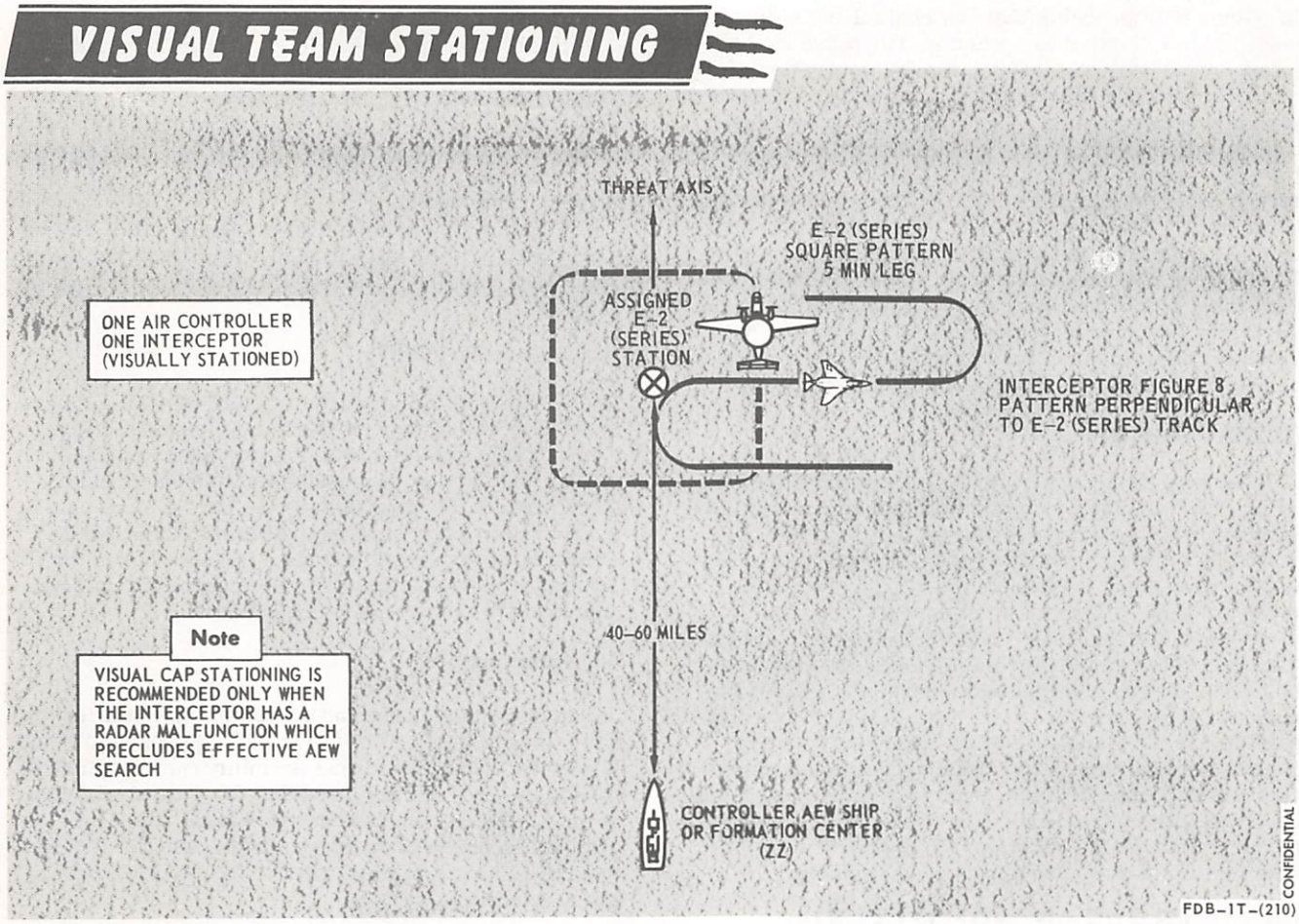


Figure 3-13 (C)

(C)

(4) Reduce the cycle time about 10 to 15 percent from the optimum.
(5) Reduces the on-station time about 15 minutes for every 50 miles of distance from the carrier.
(6) Limits capability against high, fast raids.

(C) In general the low-far CAP station is most advantageous if only one quadrant requires protection, or if enemy surveillance radar overlaps the task force zone of influence.

(U) HIGH-NEAR CAP STATIONING

(C) The high-near CAP station is defined as near or over the vital area at an altitude that conflicts with SAM zones, or from which an interceptor, commensurate with weather, would require a substantial length of time to descend to the altitude of a low flyer. Advantages and disadvantages of the high-near CAP station are as follows:

a. Advantages.

(1) Provides all-quadrant protection against medium and high altitude raids.
(2) Allows maximum cycle time.
(3) Concentrates the interceptors against enemy raids.

b. Disadvantages.

(1) If the interceptor is equipped with a pulse only radar, it will be difficult to detect low flyers or descending raids.
(2) Conflicts with SAM zones.
(3) Can be used by enemy long range surveillance radar to locate the task force.
(4) Requires a large CAP station turn radius.

NEW NEW

(C) In general, the high-near CAP station utilizes the maximum capability of the F-4B/N only when the task force does not have conflicting SAM zones and when all-quadrant protection against medium and high altitude raids is desired. If the F-4J Pulse Doppler radar is utilized, it will provide the same detection against inbound raids at all altitudes.

(U) HIGH FAR CAP STATIONING

(C) The high-far CAP station is located about 50 to 150 miles from the vital area. The altitude of the high-far CAP station is the same as that of the high-

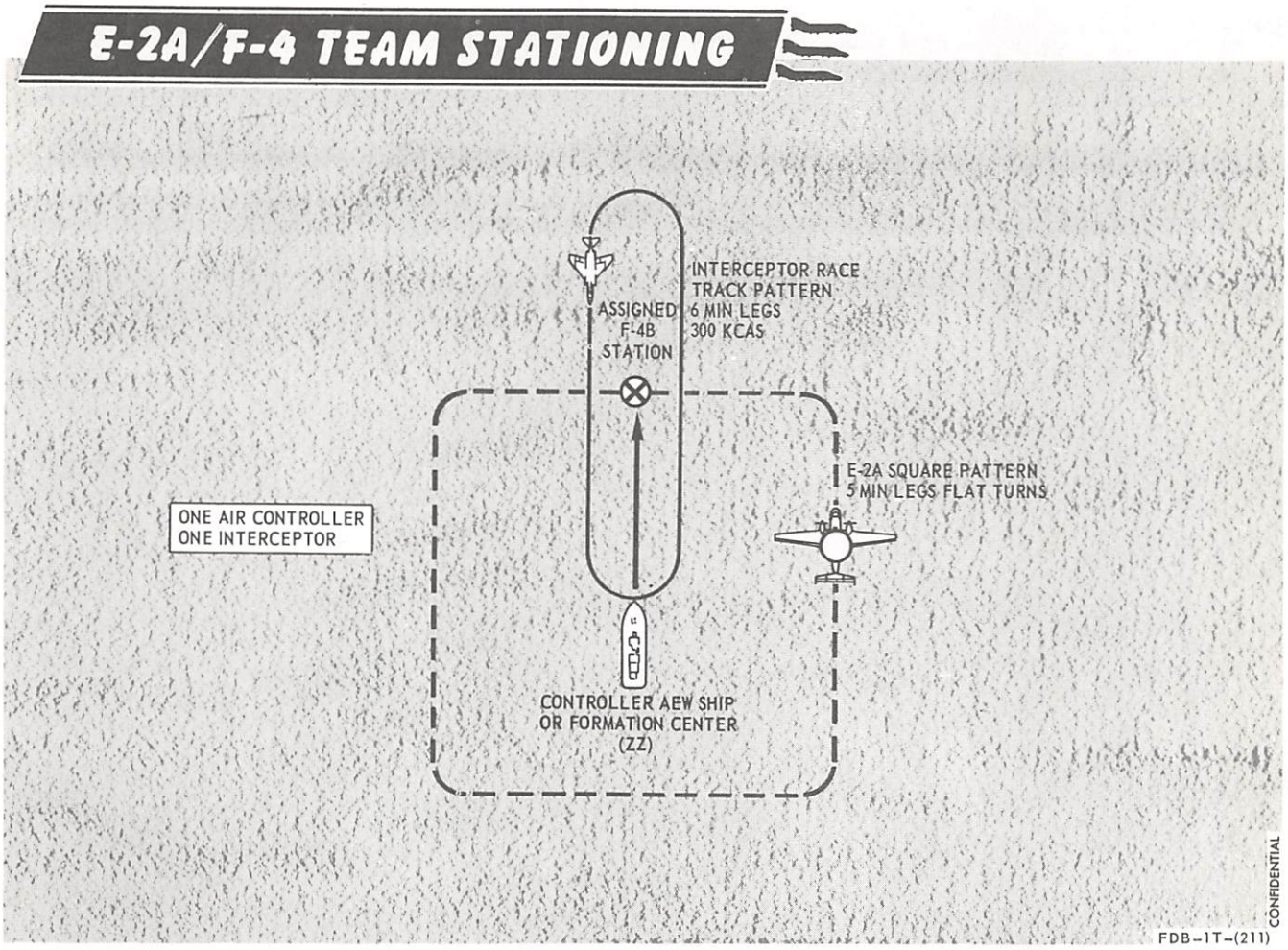


Figure 3-14 (C)

(C)
near CAP station. Advantages and disadvantages of the high-far CAP station are as follows:

a. Advantages.

(1) Depending on the type of radar system available (AN/APQ-72 or AN/APG-59), it will permit intercepts and identification runs against low, medium, and high altitude raids at extended range in one quadrant.
(2) Does not normally require picket ship or AEW for CAP station control.
(3) Separates the interceptor and SAM zones.

b. Disadvantages.

(1) If the interceptor is equipped with a pulse only radar, it will be difficult to detect low flyers and descending raids unless the raids remain at altitude until reaching the high-far CAP station.
(2) Does not provide all-quadrant protection for the vital area unless a large number of interceptors are employed.
(3) Cannot be used when enemy GCI zones overlap task force zones.
(4) On-station time is reduced about 15 minutes per 50-miles distance from carrier.
(5) Requires a large CAP station turn radius.

(U) In general, the high-far CAP station utilizes the maximum capability of the airplane when one-quadrant protection against medium and high altitude raids is desired.

(U) LONG RANGE CAP STATIONING

(C) The long range CAP station is normally a form of barrier CAP (BARCAP). It is defined herein as being beyond the normal task force early warning range, at distances of 150-300 miles. The altitude can be very low to remain below enemy surveillance radars, or at about 20,000 feet for optimum use of the AEW capability of the radar against medium altitude raids. The F-4B/N and F-4J are the first naval interceptors with the potential for exploiting this CAP station. Advantages and disadvantages of the long range CAP station are as follows:

a. Advantages.

(1) Provides long range quadrant intercepts against snoopers.
(2) Provides long range one-quadrant protection against potential low flyers and descending raids by completing the intercept before the raids descend from cruise altitude.

(C)

(3) Does not conflict with SAM zones.
(4) Provides long range identification of raids in one-quadrant:

b. Disadvantage.

(1) Requires long range picket or AEW airplane control for full effectiveness.

(2) Provides limited sector protection for the task force.
(3) The on-station time is reduced 15 minutes for every 50 miles distance from the carrier.
(4) Requires maximizing cycle time with three external tanks and/or air-to-air refueling.

(C) In general, the long range CAP station provides the task force with very long range quadrant intercepts against snoopers and enemy raids.

SECTION IV

NUCLEAR AIR-TO-GROUND WARFARE

(U) Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

SECTION V

ENEMY DEFENSE AND FRIENDLY COUNTERMEASURES

(U) Refer to Secret Supplement, NAVAIR 01-245FDB-1T (A)

APPENDIX A
AIRCRAFT LIMITATIONS

TABLE OF CONTENTS

Aircraft A-1
External Stores A-3
Fuzing A-3

AIRCRAFT

(U) GENERAL

NEW (U) The limitations quoted herein are associated with F-4B/N and F-4J aircraft in a combat (or combat training) environment. Refer to section I (part 4) of NAVAIR 01-245FDB-1 or NAVAIR 01-245FDD-1 for all other operating limitations.

(U) AIRSPEED LIMITATIONS

(U) The maximum permissible airspeeds in smooth or moderately turbulent air with arresting hook, landing gear, and wing flaps retracted, and with speedbrakes retracted or extended are as shown in figure A-1. Carriage and release speeds for the various external stores are shown in figure A-5.

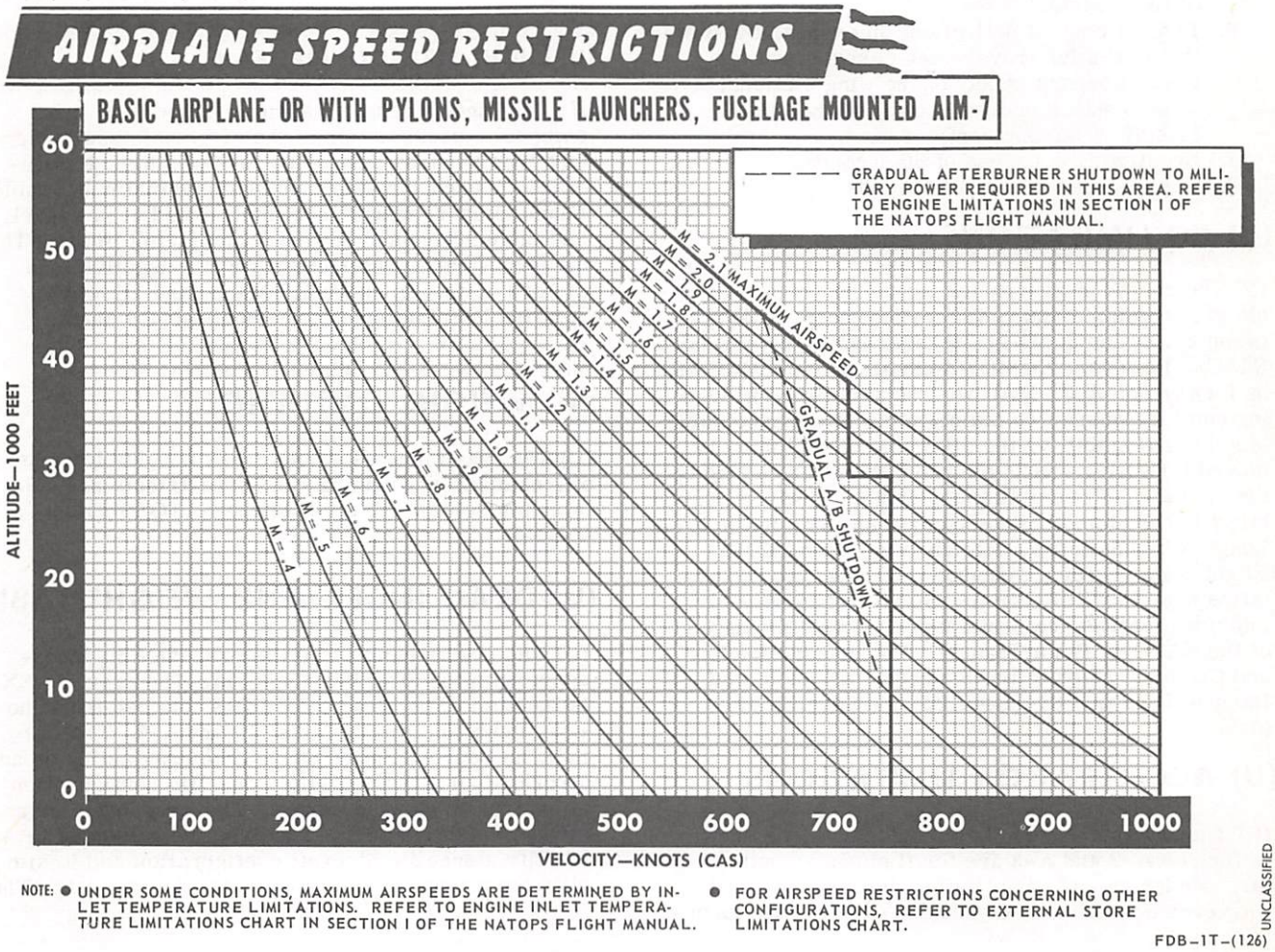


Figure A-1 (U)

CAUTION

When flying at airspeeds in excess of 350 knots CAS below 10,000 feet with CG location aft of 32.0% MAC, avoid abrupt control motions. The CG location aft of 32.0% MAC will normally occur whenever full internal fuel is maintained in conjunction with external stores.

(U) PROHIBITED MANEUVERS

1. Full-deflection aileron rolls in excess of 360°.
2. Intentional spins.
3. Abrupt control movements when carrying the 600-gallon tank (with or without fuel).
4. Lateral control deflections in excess of 1/2 of the total stick travel when carrying the 600-gallon or 370-gallon external tanks (with or without fuel), conventional weapons on the centerline station, or when launching missiles from the wing station pylons. This restriction does not apply when in the takeoff or landing configuration.
5. With the AFCS engaged, intentional maneuvers that exceed the automatic disengagement limits of the system.
6. Lateral control deflections in excess of 1/3 of the total stick travel when carrying conventional weapons on any of the wing stations. This restriction does not apply when in the takeoff or landing configuration.
7. Negative G in excess of 30 seconds.
8. Zero G in excess of 10 seconds.

(U) CG LIMITATIONS

(U) The center of gravity for all currently permissible gross weights and configurations must be kept between 27.0% and 36.0% of the mean aerodynamic chord (MAC). However, the maximum allowable aft CG will be forward of 36.0% MAC with certain external loading configurations. To maintain minimum acceptable longitudinal stability, the allowable aft CG must be moved forward as wing-mounted stores are added to the airplane. The minimum acceptable level of stability is based on airplane controllability. Refer to Longitudinal Stability, section IV of the NATOPS Flight Manual, for a discussion of flight characteristics near the aft CG limit. Stability numbers for individual stores are contained in section XI (part 1) of the NATOPS Flight Manual. For precise loading and CG data, refer to the Handbook of Weight and Balance Data (AN 01-1B-40) for the specific airplane.

(U) ACCELERATION LIMITATIONS

(U) The maximum permissible accelerations shown in figures A-2 and A-3 are for flight in smooth air. Moderate and heavy buffet should be avoided whenever possible. In conditions of moderate turbulence, it is essential that accelerations resulting from deliberate maneuvers be reduced 2.0 G below that shown in figure A-2. This is to minimize the possibility of overstressing the airplane as a result of the combined effects of gust and maneuvering loads. Carriage and release acceleration limitations for the various external stores are shown in the External Stores Limitations chart, this appendix.

CAUTION

Normal accelerations of 8.5G are permissible only when gross weight and airspeed are equal to or less than 37,500 pounds and 0.72 Mach respectively. Acceleration to 8.5G at conditions outside these limitations will impose excessive stresses on aircraft structure. Since aircraft fatigue life depends largely on the number and magnitude of G application, accelerations above 6.5G should be used only as necessary in mission performance. Care should be taken to avoid G overshoot beyond authorized limits under all conditions.

(U) FLIGHT STRENGTH DIAGRAM

(U) The flight strength diagram (figure A-3) is a composite presentation of the airplane's operating envelope at three different gross weights. Parameters of each envelope include maximum allowable Mach number, wings-level stall speed at sea level, and the positive and negative load factor limits. This diagram further restricts allowable negative load factors at speeds above 1.5 Mach, and allowable positive load factors at speeds above 1.8 Mach.

(U) WEIGHT LIMITATIONS

(U) The maximum allowable gross weights for takeoff, catapulting, landing, and arrestments are contained in section I (part 4) of the NATOPS Flight Manual.

(U) DRAG INDEX AND WEIGHT TABLE

(U) The cruise control data is presented in accordance with the drag index system. The drag INDEX is the sum of the drag NUMBERS obtained from the drag index and weight table, figure A-4. The drag index is representative of the true drag acting on an aircraft that is loaded with a specific configuration of externally carried stores. The drag index for a clean airplane is zero. The drag index is used to identify a specific aircraft configuration and to simplify the presentation of the cruise control data. The

interference drag between multiple stores on a single station is included in the drag numbers listed on the table; therefore, when a single store is carried, the computed drag index will be slightly conservative. The drag index for a specific aircraft configuration is computed by multiplying the drag number of the store by the number of stores to be carried, and then adding the drag number of the suspension equipment.

(U) EXAMPLE WEIGHT COMPUTATION

(U) Compute the aircraft gross weight and drag index to determine which column in the Range Constants tables should be used. Straightline interpolation between drag/gross weight columns is permissible. For situations varying widely from the tables presented, use the applicable NATOPS manual.

	WEIGHT	DRAG
Clean F-4B aircraft *	28,794 lbs.	0
(1) Aero 27A Ejector **	51	0
Internal fuel	13,505	0
External fuel	4,080	0
(12) MK 81 LDGP Bombs	3,120	9.6
(4) Sparrow III Missiles	1,608	5.2
(1) 600-Gal. Tank	249	9.6
(2) Pylon, Adapter, MER	682	19.0
(2) Pylon, Adapter, TER	538	16.4
Totals	52,627	59.8

* Refer to NATOPS or Weight & Balance Manuals for aircraft weights by BUNO.

** Add to F-4B/N and F-4J basic weight for all computations.

EXTERNAL STORES

(U) GENERAL

NEW

(U) Only the external stores listed in figure A-5 may be carried and release, singly or in combination, by F-4B/N and F-4J aircraft. The External Stores Limitations chart (figure A-5) illustrates authorized loading configurations; maximum permissible airspeeds and accelerations for carriage, launch, release, and jettison; maximum dive angles for release, and pertinent remarks/notes for each authorized store.

Note

Limitations for additionally authorized stores that are not covered herein are contained in section I (part 4) of the NATOPS Flight Manual.

WARNING

Ordinance shall be jettisoned above the minimum fragmentation clearance altitude when possible, even though jettison safe is selected.

(U) CARRIER OPERATIONS

(U) For carrier landing capability with hung ordnance, refer to figure A-5. Refer to the NATOPS Flight Manual, section I, part 4, for limitations on asymmetric load for carrier operations.

(U) RF TRANSMISSION LIMITATIONS

(C) The minimum safe inflight separation distance between an aircraft with an AN/AWG-10 operating in the pulse doppler mode (850 watts average power) and any other aircraft with any current externally carried store is 65 feet when in the radar main beam. Aircraft with AN/AWG-10 systems have the capability of pulse mode transmission on the ground. When radiating on the ground in the pulse mode, the minimum safe separation distance between the aircraft with the AN/AWG-10 and other aircraft with external stores is 30 feet in the radar main beam, with the following exceptions:

a. During handling and loading of chemical tank MK 12 and BQM 34A (Q2C) target, 250-feet minimum safe separation distance is recommended.

b. For HERO Unsafe Ordnance, as defined in NAVORD OP 3565/NAVAIR 16-1-529, a minimum safe separation distance of 275 feet in the area of the radar main beam is recommended.

c. If the AN/AWG-10 system is overridden to radiate in the pulse doppler mode on the ground, these minimum safe separation distances are increased to 65, 200, and 475 feet respectively.

d. Where no external stores are carried, aircrews are cautioned against directing the main beam of the AN/AWG-10, while in the pulse doppler mode, at aircraft with inflight separation distances of less than 100 feet.

FUZING

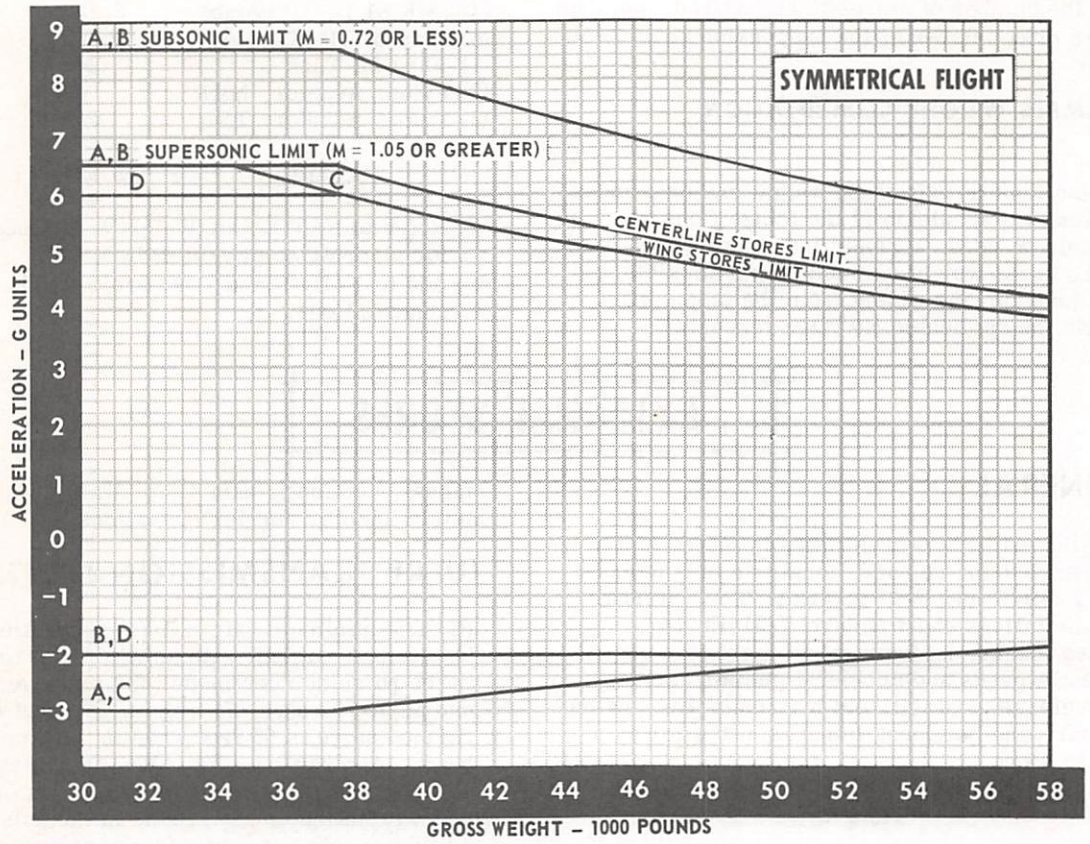
(U) BOMB FUZE LIMITATIONS

(U) Weapon carriage/delivery speeds may be further limited as a result of a particular fuze installation. Refer to part 1 of section II for limitations of individual fuzes.

ACCELERATION LIMITATIONS

Note

IN F-4B 148363f THRU 150479m DO NOT EXCEED 6.5 G.



CONFIGURATIONS:

A. BASIC AIRPLANE OR WITH PYLONS, MISSILE LAUNCHERS, FUSELAGE-MOUNTED AIM-7.
B. EMPTY 600-GALLON TANK (MCDONNELL WELDED TANK ONLY).
C. AIM-7 OR AIM-9 MISSILES AT STATIONS 2 AND 8.
D. EMPTY 370-GALLON TANKS (MCDONNELL OR SARGENT FLETCHER).

Notes

- For stores not specifically listed hereon, refer to External Stores Limitations chart. Do not exceed applicable centerline or wing stores limit curve.
- The envelope for unsymmetrical flight is from 0.0 G to 80% of the symmetrical flight limit.
- Refer to flight strength diagram for additional load factor limits at speeds above 1.5 Mach.

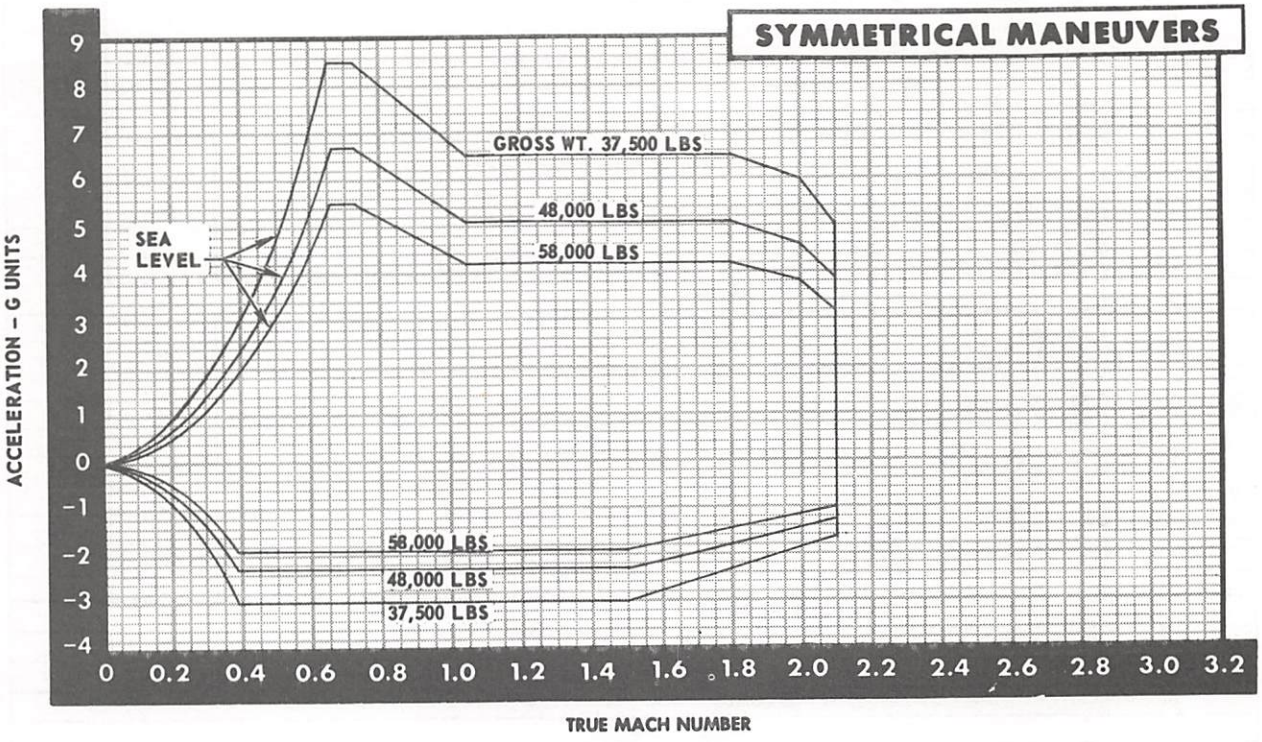
UNCLASSIFIED

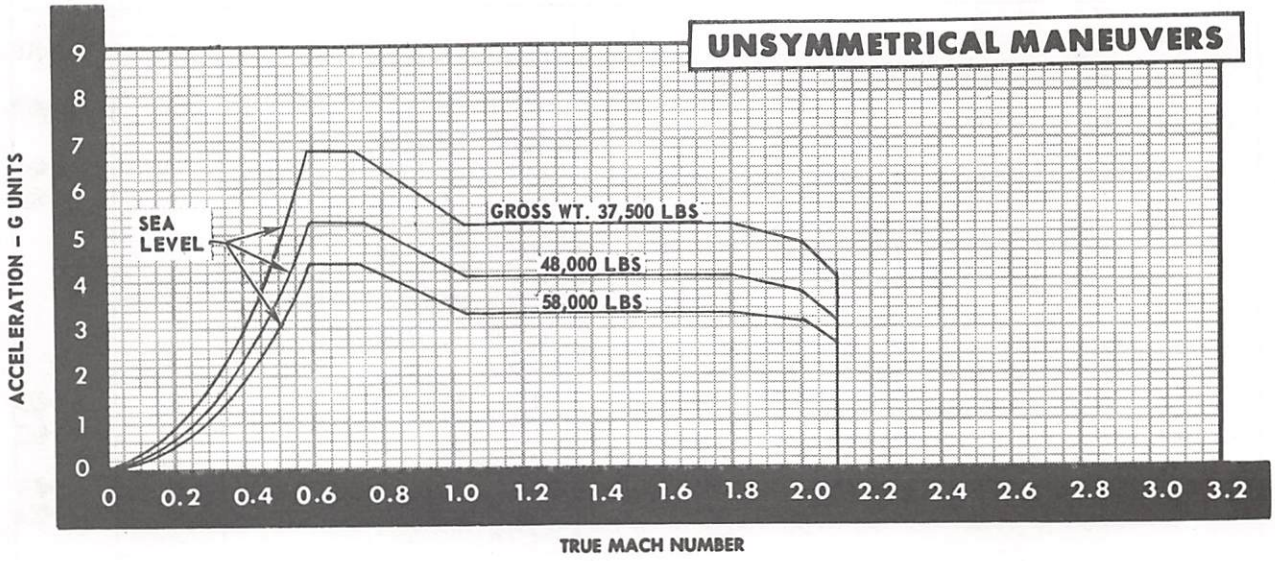
FDB-1T-(127)

Figure A-2 (U)

FLIGHT STRENGTH DIAGRAM

BASIC AIRPLANE OR WITH PYLONS, MISSILE LAUNCHERS, FUSELAGE MOUNTED AIM-7





UNCLASSIFIED

FDB-1T-(128)

Figure A-3 (U)

DRAG INDEX AND WEIGHT

STORES		UNIT WEIGHT (LBS)	UNIT DRAG
GENERAL PURPOSE BOMBS			
MK 81 LDGP		270	0.8
MK 81 SNAKEYE		300	1.2
MK 82 LDGP		531	1.1
MK 82 SNAKEYE		570	2.4
MK 82 LGB (KMU-388/B) NONEXTENDED FIN (HIGH SPEED)		668	
MK 82 LGB (MMU-388/B) EXTENDED FIN (LOW SPEED)		682	
MK 83 LDGP		985	1.8
MK 36 DESTRUCTOR (CONICAL FIN)		531	1.1
MK 36 DESTRUCTOR (SNAKEYE FIN)		570	2.4
MK 40 DESTRUCTOR (CONICAL FIN)		985	1.8
MK 40 DESTRUCTOR (MAU-91A/B FIN)		1057	3.9
PRACTICE BOMBS			
MK 76		24	0.3
MK 86 CONICAL FIN (WET SAND FILLED)		200	0.8
MK 86 SNAKEYE FIN (WET SAND FILLED)		230	NE
MK 87 CONICAL FIN (WET SAND FILLED)		330	1.1
MK 87 SNAKEYE FIN (WET SAND FILLED)		369	NE
MK 88 CONICAL FIN (WET SAND FILLED)		794	1.8
MK 106		5	0.4
MK 124 CONICAL FIN		525	NE
MK 124 SNAKEYE FIN		565	2.8
MK 89		56	0.2
CLUSTER BOMBS			
CBU-24/29/49		835	4.2
ROCKEYE II MODS 2/3		490	2.9
FIRE BOMBS			
MK 77 (MOD 4)		520	3.5
ROCKET LAUNCHERS			
LAU-32A/A	EMPTY	51	
	FULL (MK 5 WARHEAD)	179	2.7 (1)
	FULL (MK 64/151 WARHEAD)	200	
LAU-32B/A	EMPTY	53	6.3 (2)
	FULL (MK 5 WARHEAD)	181	
	FULL (MK 64/151 WARHEAD)	202	6.8 (3)
LAU-56/A	EMPTY	60	6.2 (4)
	FULL (MK 5 WARHEAD)	188	
	FULL (MK 64/151 WARHEAD)	209	
LAU-68/A	EMPTY	67	
	FULL (MK 5 WARHEAD)	195	
	FULL (MK 64/151 WARHEAD)	216	
LAU-3/A	EMPTY	73	
	FULL (MK 5 WARHEAD)	422	4.2 (1)
LAU-60/A	EMPTY	79	12.5 (2)
	FULL (MK 5 WARHEAD)	428	
LAU-61/A	EMPTY	132	13.5 (3)
	FULL (MK 5 WARHEAD)	481	12.0 (4)
	FULL (MK 64/151 WARHEAD)	538	
LAU-69/A	EMPTY	98	
	FULL (MK 5 WARHEAD)	447	
	FULL (MK 64/151 WARHEAD)	504	
LAU-10/A, -10A/A	EMPTY	112	3.6 (1)
	FULL (MK 24/32)	545	10.2 (2)
	FULL (MK 34/63)	577	11.2 (3)
	FULL (MK 33 FLARES)	525	10.0 (4)

UNCLASSIFIED

FDB-1T-(129-1)

Figure A-4 (U) (Sheet 1 of 2)

DRAG INDEX AND WEIGHT-CONTINUED

STORES		UNIT WEIGHT (LBS)	UNIT DRAG
MISSILES			
AIM-7D SPARROW III		402	FUSELAGE 1.3
AIM-7E SPARROW III		455	WING 2.6
AIM-7E/2 SPARROW III		427	
AIM-9B SIDEWINDER		157	1.7
AIM-9D SIDEWINDER		197	1.7
AIM-9G SIDEWINDER		197	1.7
AIM-9M SIDEWINDER		195	1.7
TANKS, RACKS AND PODS			
370-GALLON EXTERNAL TANK 5	EMPTY	340	4.8
	FULL	2856	4.8
600-GALLON EXTERNAL TANK	EMPTY	249	9.6
	FULL	4329	9.6
BUDDY TANK (D-704)	EMPTY	733	10.0
	FULL	2773	10.0
MK 12 SMOKE TANK	EMPTY	350	3.3
	FULL	1000	3.3
MK 4 GUN POD	EMPTY	787	11.6
	FULL	1390	11.6
CTU-1/A DELIVERY CONTAINER	EMPTY	230	4.9
NAMAR CAMERA POD		275	3.8
PYLON, MER ADAPTER & MER		341	9.5
PYLON, MER ADAPTER & TER		211	7.0
PYLON, TER ADAPTER & TER		269	8.2
CENTERLINE MER ADAPTER & MER		270	10.0
CENTERLINE MER ADAPTER & TER		150	7.5
PYLON, (1) LAU-7/A LAUNCHER & ADAPTER, TER ADAPTER & TER (CONVENTIONAL AND AIM-9)		391	9.5
PYLON, (2) LAU-7/A LAUNCHER & ADAPTERS, TER ADAPTER & TER (CONVENTIONAL AND AIM-9)		513	10.8
PYLON & (1) LAU-7/A LAUNCHER (AIM-9)		237	2.8
PYLON & (2) LAU-7/A LAUNCHERS (AIM-9)		324	3.2
PYLON (AIM-7)		150	2.4
C MER ADAPTER (55 LBS.) (GUN POD) L & HUGHES ADAPTER (16 LBS)		71	5.9
PMBR EMPTY	PYLON, MER ADAPTER & PMBR	203	7.9
	PYLON, TER ADAPTER & PMBR	261	9.1
	PMBR	87	4.9

NOTES

- THE DRAG INDEX OF THE CLEAN AIRPLANE IS ZERO.
- INDIVIDUAL STORE DRAG X NUMBER OF STORES TO BE CARRIED + SUSPENSION EQUIPMENT DRAG (IF NOT INCLUDED) = DRAG INDEX
- DRAG NUMBERS FOR SINGLE STORES ARE SLIGHTLY CONSERVATIVE. INTERFERENCE DRAG BETWEEN MULTIPLE STORES HAS BEEN CONSIDERED.
- NE = NOT ESTABLISHED
- NA = NOT APPLICABLE

1 NOSE AND TAIL CONES ON
2 NOSE CONE OFF TAIL CONE ON
3 NOSE AND TAIL CONES OFF – FULL
4 NOSE AND TAIL CONES OFF – EMPTY
5 DRAG INDEX AND WEIGHT INCLUDES THE WING TANK PYLON

Estimated operating weight (Basic airplane plus the weight of oil, unusable fuel, and two crewmembers).

F-4B Airplanes:	148363f thru 149474k	28,000 lbs.	F-4J Airplanes:	153071z thru 153087aa	29,834 lbs.
	150406L thru 150651n	28,700 lbs.		153768ab thru 155528ag	30,280 lbs.
	150652o thru 152215t	28,800 lbs		155529ag and up	31.420 lbs.
	152216u thru 152331x	28,950 lbs.		158355at thru 158365	31,665 lbs.
	152965y, and up and F-4N	29,000 lbs.			

UNCLASSIFIED

FDB-1T-(129-2)

Figure A-4 (U) (Sheet 2 of 2)

EXTERNAL STORES LIMITATIONS

BOMBS

STORES	LOAD CODE	STATION LOADING					TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)		
									CARRIAGE	RELEASE	JETTISON
BOMBS		1	2	5	8	9			KCAS/IMN	KCAS/IMN	KCAS/IMN
MK-81 CONICAL TAIL MK-81 SNAKEYE TAIL MK-82 CONICAL TAIL	A	1,2,3,6,4,5		1,2,3,6,4,5		1,2,3,6,4,5	MER (SHIFTED FWD)	TOSS, DIVE OR LEVEL	550/1.1	UNRETARDED 550/1.1 RETARDED 500/0.9	6 MER OR TER AT STA 1, 5 & 9: 275 KCAS TER AT STA 2 & 8: MAX 550 KCAS OR 1.1M MIN 175 KCAS
MK-82 SNAKEYE TAIL MK-36 DESTRUCTOR SNAKEYE TAIL OR CONICAL TAIL	B	2,3,1	2,3,1	2,3,1	3,2,1	3,2,1	TER	2			
	C	ALTERNATE LOADING FOR MK-81 & MK-82 SERET CLUSTER RELEASES 1,3,5		1,3,5		1,3,5	MER (SHIFTED FWD)	DIVE OR LEVEL	550/1.1	500	MER OR TER AT STA 1, 5 & 9: 275 KCAS TER AT STA 2 & 8: MAX 550 KCAS OR 1.1M MIN 175 KCAS
	D	2,3	2,3	2,3	3,2	3,2	TER				
MK-83 CONICAL TAIL MK-40 DESTRUCTOR CONICAL TAIL	E	6,4		1,4,5		4,6	MER (OUTBD SHIFTED AFT/ CENTERLINE FWD)	TOSS, DIVE OR LEVEL	550/1.1	550/1.1	MER AT STA 1, 5 & 9: MAX 450 KCAS OR 1.1M MIN 175 KCAS TER AT STA 2 & 8: MAX 550 KCAS OR 1.1M MIN 175 KCAS TER AT STA 1, 5 & 9: 275 KCAS
	F	1,2	2, 1 4	3,2,1	3, 1 4	1,3	TER	5			
MK-40 DESTRUCTOR MAU-91A/B FIN	G	6, 4		1, 4, 5		4,6	MER (OUTBD SHIFTED AFT/ CENTERLINE FWD)	DIVE OR LEVEL	550/1.1	550/1.1	MER AT STA 1, 5 & 9: MAX 450 KCAS OR 1.1 M MIN 175 KCAS TER AT STA 2 & 8: MAX 550 KCAS OR 1.1 M MIN 175 KCAS TER AT STA 1, 5 & 9: 275 KCAS
	H		2,3	2,3	3,2		TER				

UNCLASSIFIED

FDB-1T-(130-1)

Figure A-5 (U) (Sheet 1 of 16)

ACCELERATION G		MAX DIVE ANGLE AT RELEASE	COCKPIT SW POSITION		MULTIPLE RACK SW SETTING	REMARKS
CARRIAGE	RELEASE	DEGREES	WPN SEL	INTRVL		SEE GENERAL NOTES 1 THRU 12, 17, 18, 19 AND 20.
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM-METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0	UNRETARDED 70°	RIPPLE	100 [1]	ROCKET NORMAL (SINGLE)	A. FOR LOAD CODE B, BOMBS MAY BE CARRIED BOTTOM AND INBOARD ON STATIONS 2 AND 8 WITH OUTBOARD STATION EMPTY. B. WHEN LOADING MK-82/36 AS SHOWN IN LOAD CODES A AND B, INSURE THAT THE MAXIMUM TAKEOFF/CATAPULT GROSS WEIGHT IS NOT EXCEEDED. [1] 60MS MAY BE USED IF ONLY THE WING STATIONS ARE SELECTED OR IF IAAC 558 IS INCORPORATED. [2] TOSS DELIVERY IS NOT AUTHORIZED FOR MK 36, NOR FOR OTHER WEAPONS IN THE RETARDED MODE. [3] FOR TOSS DELIVERY (4.0g RELEASE) 60MS MAY BE USED IF ONLY THE OUTBOARD WING STATIONS ARE SELECTED, OR IF IAAC 558 IS INCORPORATED. [4] THIS MODE NOT AUTHORIZED WITH ALL STATIONS SELECTED. [5] MINIMUM INTERVAL BETWEEN SERET BOMBS FROM THE SAME RACK THAT WILL PREVENT BOMB-TO-BOMB COLLISION IS 200MS FOR MK-81SE AND 280MS FOR MK-82SE WHEN RELEASING SERET BOMBS. STATION FIVE MUST BE RELEASED SINGLE UNLESS IAAC 558 IS INCORPORATED. [6] JETTISON SPEED FOR MER AT STATION 5 WITH MK 81/82 WITH SNAKEYE TAIL FIN UNRETARDED AND 36-INCH FUZE EXTENSION IS 200 KCAS MINIMUM AND 400 KCAS MAXIMUM. X – HOOK CLOSED
			CLUSTER	100 [3]		
			SINGLE	—	ROCKET NORMAL [4] AUTO RIPPLE	
		RETARDED 60°	RIPPLE	140 [5]	ROCKET NORMAL	
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM-METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0	RETARDED 60°	CLUSTER	140	ROCKET NORMAL	
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM-METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0 [6]	UNRETARDED 70°	RIPPLE	100 [1]	ROCKET NORMAL	A. DO NOT LOAD INBOARD FORWARD MER STATION ON F-4J WING STATIONS 1 AND 9 DUE TO MLG DOOR INTERFERENCE. [1] 60MS MAY BE USED IF ONLY THE WING STATIONS ARE SELECTED, OR IF IAAC 558 IS INCORPORATED. [2] FOR TOSS DELIVERY (R.P$_g$ RELEASES) 60MS MAY BE USED IF ONLY THE OUTBOARD WING STATIONS ARE SELECTED OR IF IAAC 558 IS INCORPORATED. [3] THIS MODE NOT AUTHORIZED WITH ALL STATIONS SELECTED. [4] BOTTOM TER STATION ON AIRCRAFT STATIONS 2 AND 8 NOT AUTHORIZED FOR CATAPULT LAUNCH OR ARRESTED LANDINGS. [5] TOSS DELIVERY FROM STATIONS 2 AND 8 IS NOT AUTHORIZED. [6] AUTHORIZED RELEASE ACCELERATION ENVELOPE FOR STATIONS 2 AND 8 IS +0.5 TO + 2.0G.
			CLUSTER	100 [2]		
			SINGLE	—	[3] AUTO RIPPLE	
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM-METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0 [1]	RETARDED 70°	RIPPLE	100	ROCKET NORMAL	A. DO NOT LOAD INBOARD FORWARD MER STATION ON F-4J WING STATIONS 1 AND 9 DUE TO MLG DOOR INTERFERENCE. B. MINIMUM INTERVAL BETWEEN BOMBS FROM THE SAME MER WHEN RELEASING THE MK-40 IS 280MS. MINIMUM TER INTERVAL IS 140MS. [1] AUTHORIZED RELEASE ACCELERATION ENVELOPE FOR STATIONS 2 AND 8: +0.5 TO +2.0G X – HOOK CLOSED
			CLUSTER	140		
			SINGLE	—		

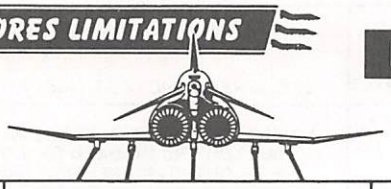
UNCLASSIFIED

FDB-1T-(130-2)

Figure A-5 (U) (Sheet 2 of 16)

[redacted]

EXTERNAL STORES LIMITATIONS



BOMBS

STORES	LOAD CODE	STATION LOADING					TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)		
									CARRIAGE	RELEASE	JETTISON
BOMBS		1	2	5	8	9			KCAS/IMN	KCAS/IMN	KCAS/IMN
CBU-24,-29,-49 MODELS /B, /B (MODIFIED), A/B AND C/B	I	3,4		3,5,4,6		5,6	MER (SHIFTED FWD)	DIVE OR LEVEL	550/1.1	550/1.1	275
	J	1,2	2,3	2,3,1	3,2	1,3	TER				
MK-77 MOD 4 FIRE BOMB	K	3,6,4		1,4,6		4,5,6	MER (SHIFTED FWD)	DIVE OR LEVEL	475/0.9	450/0.85	275
	L		2,3		3,2		TER				
ROCKEYE II	M	1,2,4,5,3,6		1,4,5,6,3		1,2,4,5,3,6	MER (FWD)	DIVE OR LEVEL	550/0.9	550/0.9	275
	N	1,2,3	2,3	2,3,1	3,2	1,3,2	TER				
MK 82 LASER GUIDED BOMB (HIGH SPEED)	O						MER (SHIFTED FWD)	TOSS, DIVE OR LEVEL	550/0.97	550/0.97	MER OR TER STA. 1, 5, AND 9 275 TER ON STA. 2 AND 8 MAX: 550/0.97 MIN: 175
MK 82 LASER GUIDED BOMB (HIGH SPEED OR LOW SPEED)	P						TER				

CONFIDENTIAL

FDB-1T-(130-3)

Figure A-5 (C) (Sheet 3 of 16)

[redacted]

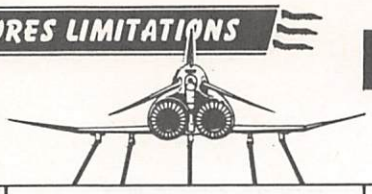
ACCELERATION G		MAX DIVE ANGLE AT RELEASE	COCKPIT SW POSITION		MULTIPLE RACK SW SETTING	REMARKS
CARRIAGE	RELEASE	DEGREES	WPN SEL	INTRVL		SEE GENERAL NOTES 1 THRU 11, 17, 18 AND 20.
SYMMETRICAL FLIGHT −0.5 TO +4.0 UNSYM — METRICAL FLIGHT 0.0 TO +2.8	+0.5 TO +4.0 2	60°	RIPPLE	100 1	ROCKET NORMAL	A. ARRESTED LANDINGS NOT AUTHORIZED. B. CATAPULT LAUNCHES OF A/B NOT AUTHORIZED. 1 60MS MAY BE USED IF ONLY THE WING STATIONS ARE SELECTED. 2 AUTHORIZED RELEASE ACCELERATION ENVELOPE FOR STATIONS 2 AND 8 IS +0.5 TO +2.0G.
			CLUSTER	140		
			SINGLE	—		
SYMMETRICAL FLIGHT 0.0 TO +4.0 UNSYM — METRICAL FLIGHT 0.0 TO +3.2	+1.0 TO +2.5	STA 1,5, & 9 20° STA 2 & 8 15°	RIPPLE	100 1	ROCKET NORMAL	1 60MS MAY BE USED IF ONLY THE WING STATIONS ARE SELECTED.
			CLUSTER	140		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM — METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0	70°	RIPPLE	100 1	ROCKET NORMAL	1 60MS MAY BE USED IF ONLY THE WING STATIONS ARE SELECTED.
			CLUSTER	140		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM— METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +4.5	60°	SINGLE	—	ROCKET NORMAL	A. NO AIM-9 MISSILES OR LAU-33/35 ZUNI LAUNCHERS CAN BE FITTED TO INBOARD SIDE OF STATIONS 2 AND 8 LAU-17 PYLON WHEN MK 82 LGB (LOW OR HIGH SPEED) IS CARRIED ON THESE STATIONS. B. LGB FITTED TO MER STATION 3 MUST HAVE GUIDANCE AND CONTROL UNIT AND FIN ROTATED 22 1/2° CLOCKWISE (VIEWED FROM REAR). C. LGB FITTED TO MER STATION 5 MUST HAVE GUIDANCE AND CONTROL UNIT AND FIN ROTATED 22 1/2° COUNTER CLOCKWISE (VIEWED FROM REAR).

CONFIDENTIAL
FDB-1T-(130-4)

Figure A-5 (U) (Sheet 4 of 16)

EXTERNAL STORES LIMITATIONS

ROCKETS



STORES	LOAD CODE	STATION LOADING					TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)			
									CARRIAGE	LAUNCH	RELEASE	JETTISON
ROCKETS		1	2	5	8	9			KCAS/IMN	KCAS/IMN	KCAS/IMN	KCAS/IMN
LAU-60/A LAU-3/A AERO-7D LAU-61/A LAU-69/A ROCKET PODS (19 SHOT 2.75" FFAR)	A	1,2	2, 3, 1 [2]	2,3,1	3, 2, 1 [2]	1,3	TER	DIVE	550/1.1	550/1.1	FULL 175 TO 350 EMPTY 300 TO 450	[1]
LAU-10A/A LAU-10/A ROCKET PODS (4 SHOT ZUNI)	B	2,3,1	2,3,1 [2]	2,3,1	3,2,1 [2]	3,2,1	TER	DIVE	550/1.1	550/1.1	FULL 175 TO 275 EMPTY 300 TO 350	[1]
LAU-68/A LAU-32A/A LAU-32B/A LAU-56/A ROCKET PODS (7 SHOT 2.75" FFAR)	C	2,3,1	2,3,1	2,3,1	3,2,1	3,2,1	TER	DIVE	550/1.1	550/1.1	FULL 175 TO 350 EMPTY 300 TO 450	[1]
LAU-33A/A ROCKET LAUNCHER (2 SHOT ZUNI)	D						LAU-7A MOUNTED INBOARD ON A LAU-17/A	DIVE	475/0.9	475/0.9	NA	300 – 400

UNCLASSIFIED

FDB-1T-(130-5)

Figure A-5 (U) (Sheet 5 of 16)

ACCELERATION G			MAX DIVE ANGLE AT RELEASE	COCKPIT SW POSITION		MULTIPLE RACK SW SETTING	REMARKS
CARRIAGE	LAUNCH	REL	DEGREES	WPN SEL	INTRVL		SEE GENERAL NOTES 1 THRU 7,9,10,11,13 THRU 18,20 AND 21.
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYMMETRICAL FLIGHT 0.0 TO +4.0	0.0 TO +4.5	1.0	70°	RKT DISP	—	ROCKET NORMAL	A. AFTER FIRING OR ATTEMPTS TO FIRE, ROCKET PODS MUST BE JETTISONED. B. WHEN CARRYING THE MAXIMUM ALLOWABLE STORE LOADING ON TER'S AT STATIONS 1 AND 9, OBSERVE THE FOLLOWING ACCELERATION LIMITATIONS: SYMMETRICAL FLIGHT: 0.0 TO +4.0. UNSYMMETRICAL FLIGHT: 0.0 TO +3.2. C. DO NOT LOAD LAU-60 WITH AFT FAIRING, LAU-61, OR LAU-69 ON INBOARD FORWARD MER STATION ON F-4J WING STATIONS 1 AND 9 DUE TO MLG DOOR INTERFERENCE.
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYMMETRICAL FLIGHT 0.0 TO +4.0	0.0 TO +4.5	1.0	70°	RKT DISP	—	ROCKET NORMAL	A. SEE NOTE 13. B. TO AVOID ENGINE STALLS WHEN LAUNCHING FROM STATIONS 2, 5 OR 8, RECOMMENDED LAUNCHING ABOVE 400 KCAS. IF NECESSARY TO LAUNCH BELOW 400 KCAS AND IF TACTICALLY FEASIBLE, RECOMMEND REDUCING POWER TO IDLE BEFORE LAUNCHING. C. TO AVOID THE POSSIBILITY OF ENGINE FOD FROM ROCKET DEBRIS, IT IS RECOMMENDED THAT A SLIGHT CHANGE IN FLIGHT PATH BE INITIATED WITHIN 3.5 SECONDS AFTER LAUNCHING THE FIRST ROCKET. D. DO NOT LOAD INBOARD FORWARD MER STATION OR INBOARD TER STATION ON F-4J WING STATIONS 1 AND 9 DUE TO MLG DOOR INTERFERENCE.
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYMMETRICAL FLIGHT 0.0 TO +4.0	0.0 TO +4.5	1.0	70°	RKT DISP	—	ROCKET NORMAL	A. WHEN CARRYING THE MAXIMUM ALLOWABLE STORE LOADING ON TER'S AT STATIONS 1 AND 9, OBSERVE THE FOLLOWING ACCELERATION LIMITATIONS: SYMMETRICAL FLIGHT: 0.0 TO +4.0. UNSYMMETRICAL FLIGHT: 0.0 TO +3.2.
SYMMETRICAL FLIGHT −1.0 TO +4.5 UNSYMMETRICAL FLIGHT 0.0 TO +3.6	−1.0 TO +4.5	NA	70°	NA	NA	NA	A. ONLY MK81 OR MK 82 TER LOADS ARE PERMITTED ON AIRCRAFT STATION 2 OR 8 WITH LAU-33A/A INSTALLED. B. RIPPLE FIRE IS NOT AUTHORIZED.
							1 JETTISON: FULL PODS; MER STATION 1, 5, & 9 MAX 275 MIN 175 TER STATION 2 & 8 MAX 550/1.1 TER STATION 1, 5, & 9 275 'EMPTY PODS; MER STATION 1 & 9 MAX 275 MIN 250 MER STATION 5 MAX 275 MIN 160 TER STATION 2 & 8 MAX 550/1.1 MIN 175 TER STATION 1, 5, & 9 275 2 LOADING OF BOTTOM TER STATION ON AIRCRAFT STATIONS 2 AND 8 IS NOT AUTHORIZED FOR SATS OR SHIPBOARD CATAPULTING AND ARRESTING.

UNCLASSIFIED

FDB-1T-(130-6)

Figure A-5 (U) (Sheet 6 of 16)

EXTERNAL STORES LIMITATIONS

PARAFLARES AND SENSORS

STORES	LOAD CODE	STATION LOADING					TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)		
									CARRIAGE	RELEASE	JETTISON
FLARES		1	2	5	8	9			KCAS/IMN	KCAS/IMN	KCAS/IMN
MK 24 MOD 2A MOD 3 MK 45 MOD 0 PARAFLARE	A	1,2,3 4,5,6		1,2,3 4,5,6		1,2,5 6,3,4	MER (SHIFTED FWD)	DIVE OR LEVEL	400/0.9	400/0.9	275
	B	1,2,3	1,2,3	1,2,3	1,3,2	1,3,2	TER				
SUU-40/44 MK24, MK 45 PARAFLARE DISPENSER	C	1,3				1,5	MER (SHIFTED FWD)	LEVEL	550/1.1	FLARE DISPERSING 250 TO 550 POD RELEASE FULL OR EMPTY 250 TO 275	275
	D	1,2				1,3	TER				

STORES	LOAD CODE	STATION LOADING					TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)		
									CARRIAGE	RELEASE	JETTISON
SENSORS		1	2	5	8	9			KCAS/ IMN	KCAS/IMN	KCAS/IMN
ADSID I	A	1,2,3,6,4,5				1,2,3,6,4,5	MER (SHIFTED FWD)	LEVEL	550/0.9	550/0.9	275
	B	2,3,1	2,3,1		3,2,1	3,2,1	TER				
SUU 40/44 DISPENSER WITH AN/GSQ-117/-117LS/-141 ACOUSTIC SENSORS	C	1,3				1,5	MER (SHIFTED FWD)	LEVEL	550/1.1	SENSOR DISPENSING 160 TO 550 POD RELEASE FULL OR EMPTY 250 TO 275	275
	D	1,2				1,3	TER				

CONFIDENTIAL

FDB-1T-(130-7)

Figure A-5 (U) (Sheet 7 of 16)

ACCELERATION G		MAX DIVE ANGLE AT RELEASE	COCKPIT SW POSITION		MULTIPLE RACK SW SETTING	REMARKS SEE GENERAL NOTES 1 THRU 7,9,10,11,13,14,17 AND 18.
CARRIAGE	RELEASE	DEGREES	WPN SEL	INTRVL		
0.0 TO +3.0	1.0	30°	RIPPLE	60	ROCKET NORMAL	A. COMPLIANCE WITH AAB 347 OR 494 MANDATORY PRIOR TO CARRIAGE OF ANY PARAFLARE. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED.
			CLUSTER	100		
			SINGLE	—		
−1.0 TO +5.0	1.0	LEVEL	RKT DISP	—	ROCKET NORMAL	A. JETTISON IN EMERGENCY ONLY.

ACCELERATION G		MAX DIVE ANGLE AT RELEASE	COCKPIT SW POSITION		MULTIPLE RACK SW SETTING	REMARKS SEE GENERAL NOTES 1 THRU 7,9,10,11,13,14 AND 17.
CARRIAGE	RELEASE	DEGREES	WPN SEL	INTRVL		
0.0 TO +4.0	+1.0	LEVEL	RIPPLE	140	ROCKET NORMAL	A. CARRIER OPERATIONS ARE NOT PERMITTED.
			CLUSTER	140		
			SINGLE	—		
−1.0 TO +5.0	+1.0	LEVEL	RKT DISP	—	ROCKET NORMAL	A. CARRIER OPERATIONS ARE NOT PERMITTED. B. JETTISON IN EMERGENCY ONLY.

Figure A-5 (U) (Sheet 8 of 16)

[redacted]

EXTERNAL STORES LIMITATIONS

PRACTICE BOMBS & ROCKETS

STORES	LOAD CODE	STATION LOADING					TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)		
									CARRIAGE	RELEASE	JETTISON
PRACTICE BOMBS & ROCKETS		1	2	5	8	9			KCAS/IMN	KCAS/IMN	KCAS/IMN
MK-76 MOD 4 MOD 5	A						PMBR A/A 37B-3 OR MER & TER	TOSS, DIVE, OR LEVEL	550/1.2	550/1.2	275
MK-106 MOD 3 MOD 4	B						PMBR A/A 37B-3 OR MER & TER	DIVE OR LEVEL	500/0.95	500/0.95	275
MK-89 MOD 0	C						PMBR A/A 37B-3 OR MER & TER	DIVE OR LEVEL	550/1.2	500/0.90	275
MK-86 PRACTICE BOMB WATER/SAND FILL	D	SEE MK-81 MER & TER LOADS					MER & TER	DIVE OR LEVEL	550/1.1	500/0.9	275
MK-87 PRACTICE BOMB WATER/SAND FILL	E	SEE MK-82 MER & TER LOADS					MER & TER	DIVE OR LEVEL	550/1.1	500/0.9	275
MK-88 PRACTICE BOMB WATER/SAND FILL	F	SEE MK-83 MER & TER LOADS					MER & TER	DIVE OR LEVEL	550/1.1	500/0.9	275
MK-124 PRACTICE BOMB	G	SEE MK-82 MER & TER LOADS					MER & TER	DIVE OR LEVEL	550/1.1	500/0.9	275

UNCLASSIFIED

FDB-1T-(130-9)

Figure A-5 (U) (Sheet 9 of 16)

This page is [redacted]SIFIED

ACCELERATION G		MAX DIVE ANGLE AT RELEASE	COCKPIT SW POSITION		MULTIPLE RACK SW SETTING	REMARKS
CARRIAGE	RELEASE	DEGREES	WPN SEL	INTRVL		SEE GENERAL NOTES 1 THRU 7 AND 20
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0	70°	RIPPLE	60	NA	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED.
			CLUSTER	100		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +4.0	STA 1 & 9 60° STA 1,5, & 9 45°	RIPPLE	60	NA	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED. B. MER OR TER RACKS REQUIRE THE USE OF ADAPTER BRACKET P/N 71125−1.
			CLUSTER	100		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +5.0	70°	RIPPLE	60	NA	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED. B. MER OR TER RACKS REQUIRE THE USE OF ADAPTER BRACKET P/N 71125−1.
			CLUSTER	100		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +4.0	70°	RIPPLE	100	ROCKET NORMAL	A. SEE NOTES 17 AND 18.
			CLUSTER	140		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +4.0	70°	RIPPLE	100	ROCKET NORMAL	
			CLUSTER	140		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +4.0	70°	RIPPLE	100	ROCKET NORMAL	
			CLUSTER	140		
			SINGLE	—		
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM − METRICAL FLIGHT 0.0 TO +4.0	+0.5 TO +4.0	60°	RIPPLE	100	ROCKET NORMAL	
			CLUSTER	140		
			SINGLE	—		

UNCLASSIFIED

FDB−1T−(130−10)

Figure A-5 (U) (Sheet 10 of 16)

EXTERNAL STORES LIMITATIONS

TANKS, PODS AND DELIVERY CONTAINER

STORES (TANKS, RACKS AND PODS)	LOAD CODE	STATION LOADING 1	2	5	8	9	TYPE OF RACK	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS) CARRIAGE KCAS/IMN	RELEASE KCAS/IMN	JETTISON KCAS/IMN
370 GALLON EXTERNAL WING TANKS MCDONNELL/ SARGENT FLETCHER	A	●	EMPTY			●	STANDARD MULTI PURPOSE PYLON	750/1.6	—	375 BELOW 30,000 FT 410 ABOVE 30,000 FT
	B	●	EMPTY TO 3/4 FULL			●		550/1.6		
	C	●	FULL			●		550/1.6		
370 GALLON EXTERNAL WING TANKS ROYAL JET	D	●	EMPTY TO 3/4 FULL			●		550/1.6		
	E	●	FULL			●		550/1.6		
600 GALLON - EXT TANK MCDONNELL SHORT FAIRING (ACCESSORY BULLETIN 18-62 NOT INCORPORATED)	F	EMPTY TO 3/4 FULL		●			AERO-27A	600/1.8 ABOVE 30,000 FT. 0.8 BELOW 30,000 FT.	—	300/0.9
	G	FULL		●						
600 GALLON EXT TANK MCDONNELL (NESTABLE) (ACCESSORY BULLETIN 18-62 INCORPORATED)	H	EMPTY TO 3/4 FULL		●				600/1.8		
	I	FULL		●						
MCDONNELL 600 GALLON EXT TANKS (WELDED)	J	EMPTY		●				LBA	—	425/1.8 [1]
	K	EMPTY TO 3/4 FULL		●						
	L	FULL		●						
600 GALLON EXT TANK ROYAL JET	M	EMPTY TO 3/4 FULL		●				600/1.8	—	
	N	FULL		●						
MK-4 GUN POD	O			●			AERO-27A	LBA	FIRING LBA	350
EMPTY PMBR	P	▽▽	▽▽	▽▽	▽▽	▽▽	—	650/1.55	—	200
EMPTY MER	Q	▽▽		▽▽		▽▽	—	LBA	—	SEE REMARKS
EMPTY TER	R	▽	▽	▽	▽	▽				
EMPTY LAU-17	S		▽		▽		—	LBA	—	175-250/0.8

UNCLASSIFIED

FDB-1T-(130-(11)

Figure A-5 (U) (Sheet 11 of 16)

ACCELERATION G			MAX DIVE ANGLE AT RELEASE	REMARKS
CARRIAGE		RELEASE		SEE GENERAL NOTES 2,9,10,11,20, AND 21.
SYM	USYM			
−2.0 TO +6.0	0.0 TO +4.8	1.0	LEVEL	A. ARRESTED LANDINGS, BOTH SHIPBOARD AND SHOREBASED, ARE PERMITTED ONLY WITH EMPTY EXTERNAL TANKS. B. CATAPULTING WITH PARTIALLY FULL EXTERNAL TANKS IS NOT PERMITTED. C. EXTERNAL FUEL TANKS MAYBE JETTISONED ONLY WHEN FULL OR EMPTY. PARTIALLY FULL TANKS MAY NOT BE JETTISONED. D. THE SYMMETRICAL ACCELERATION LIMITATIONS FOR THE EMPTY ROYAL JET CENTERLINE TANK ARE 0.0 TO 6.5 G. E. FULL OR EMPTY ONLY 370 GALLON EXTERNAL WING TANKS CAN BE JETTISONED AT 450 KCAS IN SYMMETRICAL MANEUVERS BETWEEN 2G AND 3G BELOW 5000 FEET. HOWEVER, THIS MAY RESULT IN TANK/AIRPLANE CONTACT AND MINOR AIRCRAFT DAMAGE. 1 JETTISON OF THE 600-GAL. TANK BETWEEN 375 KCAS AND 425 KCAS BELOW 15,000 FEET MAY RESULT IN AIRPLANE CONTACT AND MINOR DAMAGE. 2 THE SYMMETRICAL ACCELERATION LIMITATIONS FOR THE EMPTY ROYAL JET CENTERLINE TANK ARE 0.0 TO +6.5 G.
−2.0 TO +5.0	0.0 TO +4.0			
−1.0 TO +4.0	0.0 TO +2.0			
−2.0 TO +5.0	0.0 TO +4.0	1.0	LEVEL	
−1.0 TO +4.0	0.0 TO +2.0			
0.0 TO +5.0	+1.0 TO +3.0	1.0	LEVEL	
+0.5 TO +3.0	+1.0 ONLY			
0.0 TO +5.0	+1.0 TO +3.0	1.0	LEVEL	
+0.5 TO +3.0	+1.0 ONLY			
−2.0 TO LBA	LBA			
−2.0 TO +6.5	0.0 TO +5.2	1.0	LEVEL	
−2.0 TO +5.0	0.0 TO +4.0			
2 0.0 TO +5.0	+1.0 TO +3.0	1.0	LEVEL	
+0.5 TO +3.0	+1.0 ONLY			
LBA		FIRING −1.0 TO +6.0	NO RESTRICTION	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED. SEE MK-4 GUN POD DESCRIPTION IN SECTION II, PART IV FOR REQUIRED COOLING TIMES.
−3.0 TO +7.0		—	—	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED.
LBA		—	—	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED. B. AIRSPEED FOR JETTISONING: ● MER AT STA 1 & 9: MAX – 550 KCAS OR 1.1 MACH; MIN – 275 KCAS ● MER OR TER AT STA 5 – MAX – 400 KCAS OR 0.9 MACH; MIN – 200 KCAS ● TER AT STA 1 & 9 – 275 KCAS ● TER AT STA 2 & 8 – MAX – 550 KCAS OR 1.1 MACH; MIN – 175 KCAS
LBA		—	—	

UNCLASSIFIED

FDB-1T-(130-12)

Figure A-5 (U) (Sheet 12 of 16)

EXTERNAL STORES LIMITATIONS

TANKS, PODS & DELIVERY CONTAINERS

STORES TANKS, RACKS AND PODS	LOAD CODE	STATION LOADING 1	2	5	8	9	TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS) CARRIAGE KCAS/IMN	RELEASE KCAS/IMN	JETTISON KCAS/IMN
CTU-1/A DELIVERY CONTAINER (MODIFIED M-4A) MAXIMUM LOAD - 3	T	▽ ▽		●▽ ▽		▽ ▽●	MER (SHIFTED FWD)	LEVEL	550/0.95	425/0.75	NOT ESTABLISHED
	U	●▽				▽●	TER				
MK-12 SMOKE TANK	V	▽	●▽ 2,3		●▽ 3,2	▽	TER	LEVEL	STA 1 & 9 450 STA 2 & 8 500	DISPENSE STA 1 & 9 450 STA 2 & 8 500	NOT ESTABLISHED
NAMAR CAMERA POD	W		●		●		LAU-17A WITH MER/TER ADAPTER	—	600/1.2	—	EMERGENCY ONLY 275

UNCLASSIFIED

FDB-1T-(130-13)

Figure A-5 (U) (Sheet 13 of 16)

ACCELERATION G		MAX DIVE ANGLE AT RELEASE	REMARKS
CARRIAGE	RELEASE		SEE GENERAL NOTES 1 THRU 7 AND 20
SYMMETRICAL FLIGHT −1.0 TO +5.0 UNSYM-METRICAL FLIGHT 0.0 TO +4.0	1.0	LEVEL	A. CARRIER OPERATIONS ARE NOT PERMITTED. B. THE CG OF THE LOADED CONTAINER (WITHOUT NOSE CONE, TAIL CONE, AND PARACHUTE) MUST BE LOCATED AT LEAST THREE INCHES FORWARD OF THE FORWARD MOUNTING LUG. C. RELEASE AT AN ALTITUDE OF 300 FEET OR GREATER AND AT A SPEED BETWEEN 300 AND 425 KCAS. D. EACH OF THE FOUR FINS MUST BE TRIMMED TO A SPAN OF EIGHT INCHES TO PROVIDE ADEQUATE CLEARANCE AND STABILITY CHARACTERISTICS.
0.0 TO +4.5	1.0	—	A. NO CARRIER OPS APPROVED. B. FIELD ARRESTMENT WITH EMPTY STORES PERMITTED. C. A/C MUST BE WASHED DOWN AFTER DROPPING AGENT.
−1.0 TO +5.0	—	—	A. CARRIER LANDINGS AND FIELD ARRESTED LANDINGS ARE PERMITTED. B. CARRIER OF SIDEWINDER NOT AUTHORIZED ON LAU-17A WHEN CARRYING NAMAR POD DUE TO FIN INTERFERENCE.

UNCLASSIFIED

FDB-1T-(130-14)

Figure A-5 (U) (Sheet 14 of 16)

EXTERNAL STORES LIMITATIONS

MISSILES

STORES			LOAD CODE	STATION LOADING							TYPE OF RACK	TYPE DELIVERY	MAXIMUM AIRSPEED OR MACH (WHICHEVER IS LESS)		
													CARRIAGE	RELEASE	JETTISON
MISSILES				2	3	4	5	6	7	8			KCAS/IMN	KCAS/IMN	KCAS/IMN
SPARROW AIM-7C AIM-7D AIM-7E	FWD STA	2.25° WING FREEDOM	A			⊕		⊕			AERO 7A	—	LBA	650	—
		21° WING FREEDOM	B			⊕		⊕			AERO 7A	—	LBA	LBA	—
	AFT STA	2.25° WING FREEDOM	C		⊕				⊕		AERO 7A	—	LBA	600 OR 1.25 M TO 22,000 575 ABOVE 22,000 FT	—
		21° WING FREEDOM	D		⊕				⊕		AERO 7A	—	LBA	LBA	—
AIM-7E2 AIM-7F	WING STA	2.25° OR 21° WING FREEDOM	E	⊕						⊕	LAU-17 PYLON	—	LBA	LBA	—
SIDEWINDER AIM-9D AIM-9G (AIM-9H TRAINING MISSILE MDU-26/A)			F	⊕						⊕	LAU-7A ATTACHED TO LAU-17 PYLON	—	LBA	LBA/1.9	300/0.9
SIDEWINDER AIM-9B			G	⊕						⊕	LAU-7A ATTACHED TO LAU-17 PYLON	—	CARRYING AND RELEASE: WITHOUT LIVE WARHEAD- 600 KCAS OR 1.5 MACH. WITH MK 8 WARHEAD- AS SHOWN ON SIDEWINDER AIM-9B AIRSPEED LIMITATIONS CHART.		300/0.9

UNCLASSIFIED

FDB-1T-(130-15)

Figure A-5 (U) (Sheet 15 of 16)

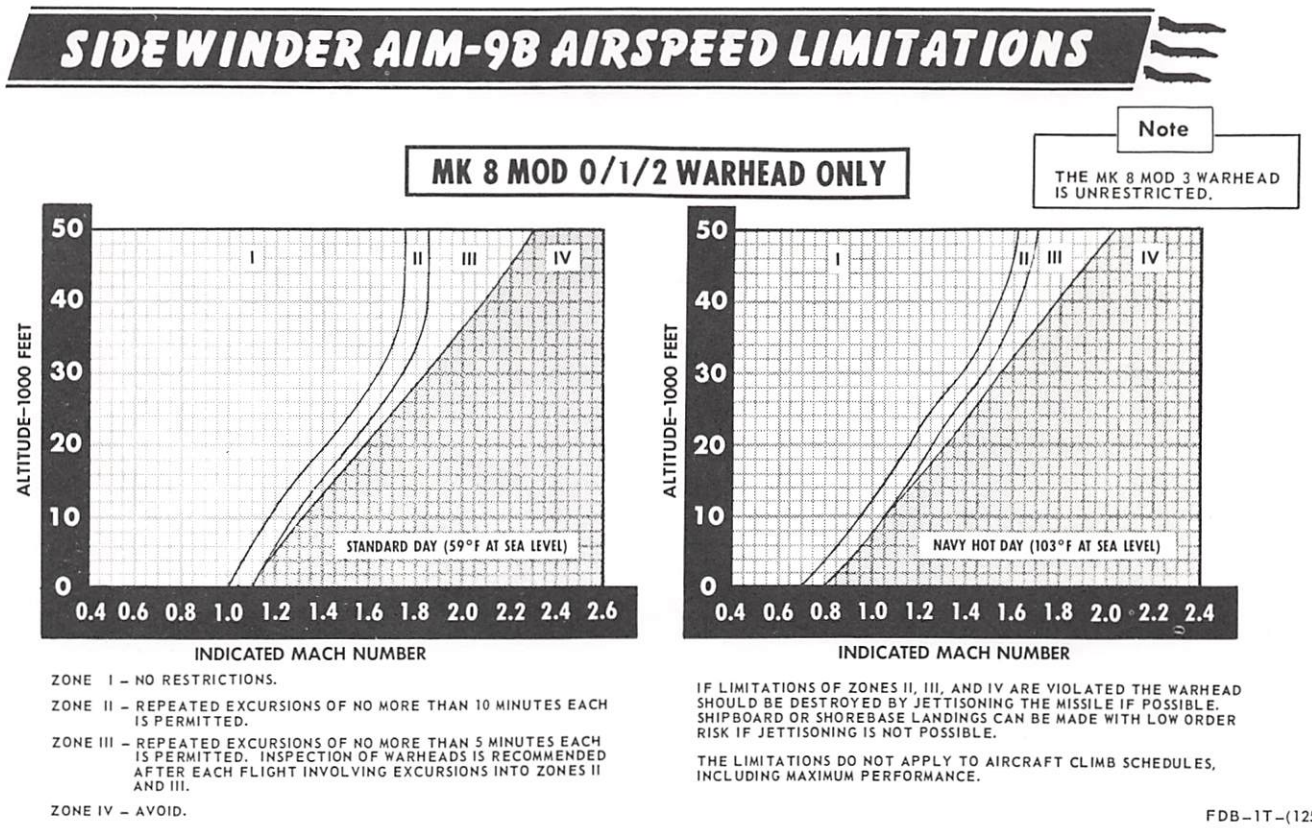

SIDEWINDER AIM-9B AIRSPEED LIMITATIONS
MK 8 MOD 0/1/2 WARHEAD ONLY
Note
THE MK 8 MOD 3 WARHEAD IS UNRESTRICTED.
ALTITUDE-1000 FEET
50
40
30
20
10
0
I
II
III
IV
STANDARD DAY (59°F AT SEA LEVEL)
0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6
INDICATED MACH NUMBER
NAVY HOT DAY (103°F AT SEA LEVEL)
0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4
ZONE I – NO RESTRICTIONS.
ZONE II – REPEATED EXCURSIONS OF NO MORE THAN 10 MINUTES EACH IS PERMITTED.
ZONE III – REPEATED EXCURSIONS OF NO MORE THAN 5 MINUTES EACH IS PERMITTED. INSPECTION OF WARHEADS IS RECOMMENDED AFTER EACH FLIGHT INVOLVING EXCURSIONS INTO ZONES II AND III.
ZONE IV – AVOID.
IF LIMITATIONS OF ZONES II, III, AND IV ARE VIOLATED THE WARHEAD SHOULD BE DESTROYED BY JETTISONING THE MISSILE IF POSSIBLE. SHIPBOARD OR SHOREBASE LANDINGS CAN BE MADE WITH LOW ORDER RISK IF JETTISONING IS NOT POSSIBLE.
THE LIMITATIONS DO NOT APPLY TO AIRCRAFT CLIMB SCHEDULES, INCLUDING MAXIMUM PERFORMANCE.
UNCLASSIFIED
FDB-1T-(125)

Figure A-6 (U)

APPENDIX B
INTELLIGENCE

(U) Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A).

APPENDIX C
QUESTION BANK

(U) The following question bank pertains to tactical employment of the aircraft and its weapons systems. The questions are subdivided into various categories relative to different types of aircraft operations, systems, and weapons.

TACTICS PHASE

1. Match the following significant airspeeds with the definitions listed at the right.

a. 220 KCAS	____ Placard c · Q limit
b. 450 KCAS	____ Minimum recommended for commencing oblique loop or vertical reversal
c. 450-500 KCAS	____ Optimum recommended for commencing oblique loop or vertical reversal
d. 750 KCAS	____ Optimum engagement and maneuvering
e. 300 KCAS	____ Minimum recommended for rolling maneuver over the top
f. 550 KCAS	____ Rudder feel changeover
g. 350 KCAS	
h. 140 KCAS	

2. Match the following angle of attack values with the definitions listed at the right.

a. 30	____ Optimum acceleration
b. 15-16	____ Hard turn, very little energy loss
c. 3-5	____ Optimum turn, excessive energy loss
d. 18-21	
e. 12	

3. When minimum radius turns are required below 420 KCAS, use of afterburner will increase sustained and instantaneous G available. T/F

4. Above 16 units AOA, use of full stick in the direction of desired turn will increase roll rate. T/F

5. Four seconds of tracking time is required before launching an AIM-9D. T/F

6. What are the rule of thumb maximum range values (NM) for the AIM-7E and AIM-7E-2 against a maneuvering target?

   Head-on _____

   Beam _____

   Tail _____ With positive V_c _____

7. You are in a block 36 F-4J commencing a VID to a stern attack with a full system lockon at 10 miles. All switches are set up properly, except you are in SAFE. Upon identification of the bogeys as MIGS, you select ARM. How long must you wait before pulling the trigger? _____ What if you were in a block 35 F-4J under the same conditions? _____ If you had no lockon, how long must you wait to pull the trigger after lockon in the block 36 F-4J? _____ What about the block 35 F-4J? _____ How long must you wait to pull the trigger after lockon in the block 46 F-4J? _____

8. To preclude the pilot from returning to the cockpit to center the radar dot in ACM, where should you place a beam aspect bogey in relation to your aircraft for an optimum AIM-7E-2 shot? _____ How about a tail aspect bogey? _____

9. The primary purpose of a barrel roll attack is to:

   a. Rapidly lose energy in order to gain a stern advantage using a classic scissors.

   b. Convert a high angle off to a lower angle off with nose to tail separation.

   c. Gain position for a head-on AIM-7 shot.

   d. Maintain nose to tail position by maneuvering in the vertical plane (two-dimensional).

10. (Pilot only) For a position on the right side of the formation, pilot lookout should commence counter-clockwise from _____° right of the nose to _____ . 75% of his time should be spent looking in this area.

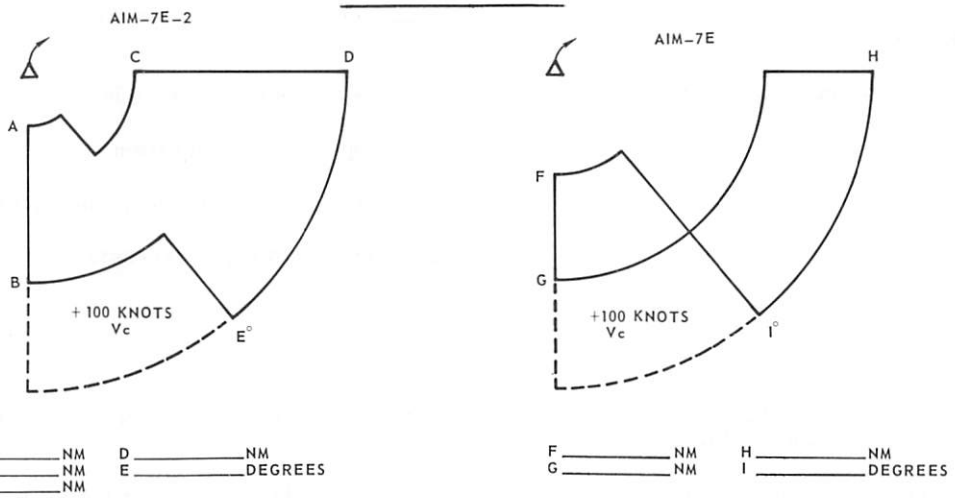
11. (RIO only) RIO lookout doctrine should consist of 15 seconds _____ , 15 seconds _____ , and 15 seconds _____ .

12. If the missile select switch is moved to HEAT immediately after firing an AIM-7 missile, the missile will/will not guide.

13. Wing position in combat spread is _____ to _____ NM abeam the lead, plus _____ to minus _____ degrees in elevation.

14. Provide the ranges and angles off required for the following listed points.

ACM LAUNCH ZONES



A _____ NM D _____ NM
B _____ NM E _____ DEGREES
C _____ NM

F _____ NM H _____ NM
G _____ NM I _____ DEGREES

UNCLASSIFIED

FDB-1T-(229)

15. An aircraft with a 24-foot wingspan would appear to be _____ mils wide at 1/2 NM, and _____ mils at 2 NM.

16. In the ACM environment, the AN/APG-59 radar set controls should normally be set on _____ MODE, _____ GYRO, _____ MSL GATE, _____ RANGE SCALE.

17. With all of the AIM-9D parameters satisfied, the pilot should ripple two missiles to increase the kill probability. T/F

18. With the guns switch in READY, which missiles can be fired?

   a. AIM-7

   b. AIM-9

   c. Both missiles

   d. Neither missile

ACM

19. What is the maximum G limitation for launching the AIM-9D?_____ The AIM-7E?_____

20. What does wing loading mean in performance considerations?_____

_____

21. What does thrust to weight ratio mean in performance?_____

_____

22. Turn radius and turn rate are dependent on what two factors?_____

_____

ANGLE OF ATTACK AND ADVERSE YAW

23. Effective lift (rate of turn) and total drag (loss of speed)_____ with an increase in AOA.

a. Increase b. Decrease

24. Adverse yaw is the tendency of the F-4 to yaw/roll in a direction opposite of that intended. This tendency is caused by _____

a. Aileron drag c. Dihedral effect

b. Shifting of the lift vector d. All of the preceding

25. Fill in the blanks on the following aircraft limitations and prohibited maneuvers.

Maximum positive G supersonic _____ G

Negative G in excess of _____ seconds

Eight and one-half G are only available below _____ Mach and 37,500 pounds gross weight.

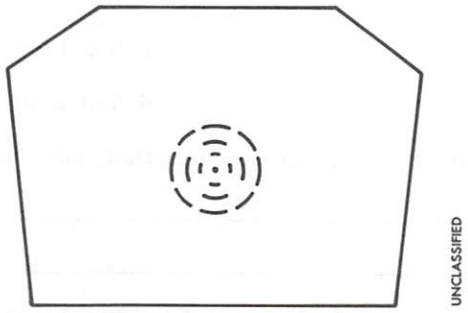
Zero G in excess of_____ seconds

MK-4 GUN POD/AIR-TO-AIR

26. To clear the MK-4 gun pod, the weapon switch (master arm) must be in CONV ON/NUCL OFF, and when cleared may not be fired again on that sortie. T/F

27. The air-to-air combat mil setting for the gunsight is _____ mils.

28. With the previous answer set in your gunsight, range to the bogey at 1500 feet, and 3 G on the aircraft, what portion of your gunsight display would you use for a MK-4 air-to-air kill. Draw an X over the spot where your bullets will go



FDB-1T-(230)

29. If the range in the preceding problem decreased to 1000 feet and all other inputs remained the same, your lead required for a kill would _____.

a. Increase b. Decrease

30. The current wide speed range of our fighters and the increased range of our weapons present problems in gunsight tracking that the pilot can no longer solve by "Kentucky Windage." T/F

31. The four factors that enter into the computation of the prediction angle (gunsight setting) are:

    a. _____

    b. _____

    c. _____

    d. _____

ENERGY MANEUVERABILITY

32. Maneuverability can be described as the ability of an aircraft to change the direction and magnitude of its velocity vector which by implication may be regarded as the ability to perform changes in altitude, airspeed, and direction. T/F

33. Match the terms and sides of the average V-N diagram

a. Aerodynamic limit _____	1. Top
b. Structural limit _____ and _____	2. Bottom
c. Maximum airspeed limit _____	3. Left
d. Instantaneous maximum rate of turn _____	4. Right

34. On maneuverability and H-M diagrams the zero P_S line indicates:

    _____

    _____

35. E_S lines reflect energy states which disregard thrust, and reflect energy resulting from altitude and velocity. T/F

36. P_S contours:

    a. Indicate unloaded flight paths.

    b. Indicate specific energy in terms of feet per minute.

    c. Plot negative values, in addition to positive values, to indicate areas in which not to fight.

    d. Plot negative values to indicate that the aircraft must, in the case of constant altitude charts, lose velocity or G, or both.

LOOSE DEUCE TACTICS AND FIGHTER MANEUVERS

37. In the Loose Deuce concept, _____ continually has the ultimate authority and responsibility for the conduct of the flight.

    a. MILLEAD

    b. MILWING

    c. TACLEAD

    d. TACWING

38. The Loose Deuce formation, as any other fighting formation, must be maneuverable plus provide:

    a. _____

    b. _____

39. When attacking multiple bogeys over neutral ground it is advisable to split the section and fight as two singles. T/F

40. What type of curve is an attacker flying when his flight path is continuously pointed at the target?

    _____

41. The force of gravity aids turning performance whenever the aircraft lift vector is below the horizon. T/F

42. The low wing loaded aircraft (MIG-17) will out turn the high wing loaded aircraft (F-4) if at the same airspeed, altitude, and G state. T/F

43. The best advantage of the head-on VID is:

    a. Initially both AIM-7 and AIM-9 option

    b. Shortest raid penetration

    c. Identification occurs in ACM launch zone

    d. None of the preceding

44. The main disadvantage of the stern VID is:

    a. Requires high aircrew proficiency

    b. Initially only AIM-7 option

    c. Identification does not occur in ACM launch zone

    d. Allows greater raid penetration

45. Minimum airspeed needed for commencing the pullup in the vertical VID is: _____ KCAS

AIM-7 MISSILE

46. In block 35 and below aircraft with the radar (CW) power ON, the missile arm switch in SAFE, and a radar lockon, the AIM-7 missile is tuned on _____.

47. The minimum V_C acceptable for firing the AIM-7E or AIM-7E-2 is:

    a. 150 knots closing

    b. co-speed

    c. 300 knots opening

    d. 150 knots opening

48. The AIM-7 forward antenna is slaved to the radar antenna and moves whenever the radar antenna moves. T/F

49. With the missile interlock switch IN, what firing parameters must be met prior to firing the AIM-7?

    _____

    _____

50. The three arming delays in the AIM-7E-2 missile that occur prior to fuzing are:

    a. 1000 feet S&A, intercept arm, and 2.5-second electronic arm

    b. End of boost arm, 2.5-second electronic arm, and intercept arm

    c. 1000 feet S&A, 1.6-second electronic arm, and intercept arm

    d. 1.6-second electronic arm, 1000 feet S&A, and intercept arm

51. If an AIM-7 missile misfires, the next missile in the sequence will automatically launch after a 2-second delay. T/F

52. Head aim:

    a. Provides pre-missile lockon steering command to the AIM-7.

    b. Commands missile forward antenna to look at the target 0.6 seconds after alunch.

    c. Is provided to fuselage missiles only.

    d. Tells the pilot the direction to turn the aircraft to maintain lock.

AIM-9D MISSILE

53. After pressing the trigger for an AIM-9D shot, you should attempt to pull as much lead as possible to help the missile prior to its leaving the rail. T/F

54. The AIM-9D should be fired in ripple to increase P_k if you know you are in the heart of the envelope. T/F

55. If coolant is not available for the AIM-9D, the missile is uselessly limited. T/F

56. The AIM-9D minimum range rules are:

AIM-9D _____ feet + _____ feet per each _____ degrees angle off.

LIGHTS, SWITCHES, AND RELATED SYSTEMS

57. You are carrying four fuselage mounted AIM-7 and a centerline tank. CAP altitude is 15,000 feet and approaching the CAP station you select missile power ON and shortly thereafter obtain aft SELECTED lights. The forward AIM-7 will/will not tune. You are vectored toward a hostile aircraft and jettison the centerline. How long will it take the forward SELECTED lights to come on?

58. With two AIM-9 missiles aboard, a loaded station will be selected each time the missile select switch is moved to HEAT REJECT. T/F

59. With HEAT selected, the computer interlock functions are bypassed and AIM-9 missiles aboard may be fired at any time if armed. T/F

60. You have a full system radar lockon for 30 seconds on a nonmaneuvering bandit with 100 knots V_c. You fire an AIM-9D at 1 mile and immediately switch the missile select switch to RADAR. How long do you have to wait to fire the AIM-7? _____

61. AIM-7 missiles may be tuned with the CW power switch ON and the APQ-72/APG-59 power switch in:

a. Test
b. Standby
c. Operate
d. All of the preceding

62. When carrying missiles and a centerline gun pod, must the missile fairing circuit breaker be pulled to fire the forward AIM-7 station missiles?

Yes/No

RADAR/WEAPONS

63. What is the normal time delay from the OFF position until the radar transmitter is ready to fire?

APG-59 _____ min. APQ-72 _____ min.

64. What is the normal time delay for the missile power (CW transmitter) to become operational in the F-4B? _____ F-4J? _____

65. The APG-59 utilizes chirp (expanded pulse) in pulse mode and all range scales. T/F

66. How is target eclipsing overcome in pulse doppler? _____

67. Automatic acquisition in pulse doppler is utilized on targets in the _____

68. With the V_c switch in LOW and VI mode selected, the 3 o'clock V_c circle position indicates _____ knots V_c.

69. Name the three phases of steering information for the F-4B. _____, _____, and _____.

70. Name the two phases of steering for the F-4J: _____ and _____.

71. Name the six prelaunch inputs supplied to a fuselage mounted AIM-7 after trigger squeeze: _____, _____, _____, _____, _____, and _____.

72. The minimum acceptable V_c for firing the AIM-7E-2 missile is _____.

73. The missile arm switch must be in the ARM position in order to tune the AIM-7 in aircraft prior to block 36. T/F

74. The two ways to initiate seeker head cooling on AIM-9D/G missiles are _____ or _____.

75. While in a reattack the radar is inadvertently turned off. The pilot has AIM-7 selected and armed, carrying four AIM-7 and four AIM-9. The pilot places the turning bogey tangent to the radome and pulls the trigger. What will happen? _____

76. While on CAP station; interlocks IN, SAFE and HEAT selected, missile power ON, and radar in PD search, will AIM-7 missiles tune? Yes/No If the missile tunes, what will be your first indications?

_____

77. The AIM-7E-2 missile with the minimum range shorting plug installed will display accurate R_a and R_{min} strobes on the pilot/RIO radar scopes. T/F

78. HEAT is selected and a SW light is illuminated; how do you get the READY light? _____

79. With the AIM-9 coolant gauge reading in high yellow or green there is approximately _____ of cooling available.

80. Selecting left wing on the selective jettison switch and depressing it allows you to:

    a. Jettison AIM-7 in the safe condition leaving wing mounted AIM-9 intact.

    b. Jettison stations one and nine.

    c. Jettison AIM-7 or left wing mounted AIM-9 in the safe condition.

81. How many seconds (approx.) are required to tune up an AIM-7 missile?

    a. CW STBY _____ b. CW OFF _____

82. What function does the missile power switch fulfill in the STBY position? _____ and _____.

83. With the gun switch in READY, AIM-7 missiles cannot be fired. T/F

84. You have had a utility hydraulic failure but still have SELECTED and READY lights; the AIM-7 missile will/will not guide.

85. Prior to block 36 aircraft, simulated doppler is supplied to the AIM-7 any time the missile power is ON and the radar is locked up and tracking a target. T/F

86. If you select ARM prior to missile power ON in aircraft prior to block 36, will the AIM-7 missile tune? Yes/No

87. If one AIM-9 is on board, it will be selected automatically when HEAT is selected. T/F

88. With the radar in full system pulse manual track and normal speedgate selected in the F-4J, what search will the AIM-7 speedgate select after launch? _____

89. You are in a 90° left bank with gyro in and full system lock with a contact 40° left, 5 miles, and level. Where will it be with gyro out? _____, _____, and _____.

90. AIM-7 missiles will tune up with the missile power switch in standby. T/F

91. With gun switch in READY, the AIM-7 missile will not tune. T/F

92. While on deck you have just finished tuning your missiles and have positioned the missile power switch to OFF. The radar function switch is in OPR and you are in the pulse mode. Are you radiating radar energy outside of the aircraft (after AVC 388)? Yes/No

93. On all F-4J, a RADAR COOL DIV CLOSED light requires the following action when airborne:

    a. Monitor utility pressure.

    b. Secure radar completely.

    c. Select pulse modes.

    d. Select pulse doppler mode.

94. When cycling through B PLUS OFF XMTR RESET the missile power switch can be left ON with four AIM-7 missiles aboard. T/F

95. You are in the VI mode and interlocks IN. Can you shoot an AIM-7? Yes/No

96. The chirp mode of the APG-59 pulse operation was designed for:

    a. High resolution of multiple targets at short range.

    b. Increasing long range detection without increasing transmitted power.

    c. Use with the PRF switching function to minimize target fade.

    d. Optimizing target angle track, range and acceleration limits computation when in full automatic track.

RADAR/FIRE CONTROL SYSTEM

97. Beam width error determines minimum target separation in _____ and _____ and may be effectively reduced by proper use of the _____ control.

98. The elevation coverage at 20 miles for a non-nutating radar beam is _____ feet and for a nutating radar beam is _____ feet. (Use beam widths applicable to your radar)

99. For the AIM-7E, what are the values of R_a for the following fire control computer situations?

    a. (APQ-72) Conversion from collision steering to lead pursuit steering. _____ R_a

    b. Maximum expansion of the ASE circle. _____ R_a

    c. R_{min} _____ R_a

APG-59 RADAR

100. When is the Break X displayed in the VI mode?

    a. When range is less than 1 mile

    b. When range is less than R_{min}

    c. When range is less than 1000 feet

    d. Never

101. With the missile select switch in the HEAT position, each time the trigger is pulled a loaded SW station will be selected and a missile fired, regardless of the interlock switch position. T/F

102. The F-4 can carry which of the following missile loads?

    a. Six AIM-9 or four AIM-9 and four AIM-7

    b. Four AIM-9 and six AIM-7

    c. Six AIM-7 or six AIM-9

    d. Six AIM-7 or four AIM-9 and four AIM-7

103. With the guns switch in READY and the aircraft airborne, AIM-7 tuned status is monitored by:

a. SELECTED lights

b. READY lights

c. Both of the preceding lights

d. Neither of the preceding lights

104. If the pilot fails to turn the AIM-9 coolant control switch ON, an AIM-9D cannot be successfully launched. T/F

105. Due to seeker head limitations, computed in-range for the AIM-7E will never exceed:

a. 0.6 R_a

b. 1.05 R_a

c. 13.5 NM

d. 8.3 NM

106. Antenna level may be ascertained by:

a. Gyro out and boresight

b. STAE

c. Degrees x miles x 100 = altitude

d. All of the preceding

107. Missile firing interlocks are automatically overridden in all but which of the following modes:

a. AOJ

b. HOJ

c. VI

d. BST (without lockon)

108. All but which of the following occurs with pilot actuation of the PLM:

a. Chirp selected

b. Feedhorn nutation

c. BST selected

d. 5-mile scale selected

109. With RADAR selected on the missile control panel, the position of the R_a strobe is determined by:

a. Missile seeker head ability to detect the target.

b. Aerodynamic range of the missile

c. The position of the interlock switch

d. None of the preceding

110. AIM-7 Fuzing occurs at:

a. End of missile boost

b. One-half of missile deceleration

c. One-half of doppler

d. None of the preceding

111. Which of the following is never an aircraft interlock for firing missiles?

a. Speed brakes

b. Wing flaps

c. Landing gear

d. Centerline store

CONVENTIONAL WEAPONS

112. When planning the release parameters for conventional ordnance delivery, the Fuze Arm Time and the FRAG Pattern will generally be the limiting factors. T/F

113. Wind correction for ordnance delivery is figured on the:

a. Surface Wind

b. Average wind 0 to 5000 feet

c. Release altitude wind

d. None of the preceding

114. You are dive bombing with a release altitude of 5000 feet and a weapon time of fall of 6 seconds. With a wind of 045/20 how many mils offset will be required to correct for the wind?

a. 045° - 41 mils

b. 090° - 40 mils

c. 045° - 2 mils

d. 255° - 2 mils

115. You are on a rocket firing mission with six pods of LAU-3A rocket launchers (19 tubes) on stations 2 and 8. How many pickles to fire all rockets on a single pass?

a. 6

b. 3

c. 2

d. 1

116. When releasing MK-82 bombs (freefall) with a M-904E2 Mech. nose fuze, what switch controls the arming of the fuze?

a. Any mode on the AN/AWW-1

b. Station select switch on dog bone

c. Arm switch (nose/tail-nose) on dog bone

d. Pickle button

117. The F-4B/J has_____ conventional ordnance loading stations with _____loading positions.

a. 5 - 18

b. 4- 24

c. 4 - 18

d. 5 - 24

118. The sight check in the F-4B/J is normally made at 190 mils. T/F

119. Carriage speed limitations are usually imposed by the _____.

a. Fuzes

b. Arming wires

c. Bomb structure

d. None of the preceding

120. Release speed limitations are imposed by the _____.

a. Fuze
c. Bomb structure
b. Arming wires
d. None of the preceding

121. Retardation feature of the Snakeye is controlled from the cockpit by the _____.

a. AWW-1
c. Arm nose/tail
b. Weapon select
d. Station select

122. The master arm switch must be in the conventional on/nuclear off position before rehoming the conventional weapons release system. T/F

123. Aircraft gross weight does effect the mil setting for weapon delivery. T/F

124. There are many variables in a dive bombing run for which a pilot must compensate. The three most important variables are:

a. Skid, bank, RO calls
c. Dive angle, airspeed, altitude
b. Dive angle, mils, seat position
d. Airspeed, altitude, bank

125. The pendulum effect is directly proportional to MIL setting. T/F

126. A bomb fuze has two major functions: the arming delay and impact delay. T/F

127. The armament safety override switch located in the front cockpit permits:

a. Continuity check of the bomb and rocket firing circuits

b. Releasing/firing of conventional ordnance while on deck if CW system armed and pickle depressed

c. Both A and B

d. One of the preceding

128. In order to obtain a .10 second ripple release of a load of bombs, the selector switch in the rear of a MER/TER-7 must be placed to auto ripple. T/F

129. When firing rockets from the inboard wing stations the speed brakes must be in the up position to satisfy the interlock. T/F

130. The pipper covers _____foot/feet at 1000 feet.

a. 1
c. 3
b. 2
d. 4

131. There are _____ mils per degree.

a. 10
c. 35
b. 17.45
d. None of the preceding

132. After firing 6 pods of rockets, the quickest way to release only the rocket pods is select _____ arm up and pickle

a. Bombs pairs
c. Bomb cluster
b. Bombs ripple
d. Bull pup

133. A shallow angle release will fall:

a. Short
b. Long

134. A steep angle release will fall:

a. Short b. Long

135. A high release will fall:

a. Short b. Long

136. A low release will fall:

a. Short b. Long

137. A fast release will fall:

a. Short b. Long

138. A slow release will fall:

a. Short b. Long

139. Positive G at release causes a hit to be:

a. Short b. Long

140. If no correction is made a headwind will cause a hit to be:

a. Short b. Long

141. If no correction is made a tailwind will cause a hit to be:

a. Short b. Long

142. Dropping with one wing low will give a hit in the direction of the _____ wing.

a. High c. Not applicable

b. Low

143. Releasing in a right skid (ball right) will cause the hit to be _____ of the aim point.

a. Right b. Long

c. Left d. Short

END OF TEST

ALPHABETICAL INDEX

Note

All numbers in this alphabetical index refer to page numbers, not paragraph and figure numbers.

	Page No. Text	Illus.
A		
*AAA Acquisition Radar, Cross Fork	5-9	
*AAA and SAM, Counter Tactics Against Both	5-187	
*AAA, Counter Tactics Against	5-186	
*AA Gun Fire Control, Types of	5-142	
*AC-130 Gun Ship System	2-2	
*AC-130 Gun Ship Delivery Tactics.	2-4	
Acceleration and Snap-Up	1-220	
Acceleration Limitations	A-2	A-4
ACM Launch Zone	1-164	
ACM Launch Zone, AIM-7E	1-165	1-165
ACM Launch Zone, AIM-7E-2	1-165	1-165
Acquisition, AN/APG-59 Radar	1-141	
Acquisition, AN/APQ-72 Radar	1-150	
Acquisition, Manual	1-151	
Acquisition, Pulse	1-142	
Acquisition, Pulse Doppler	1-142	
Acquisition, Time of.	1-141, 1-150	
Acquisition, VTAS/Radar Mode	1-152	
Additional Copies	xiv	
*Additional Deception Jammers	1-12	
*Additional Noise Techniques	1-11	
*ADF Function	1-27	
Advantages of Interceptor/Air Controller Team Concept	3-21	
Adverse Yaw, Rate of Roll and	1-4	
*Aerial Combat Between MIG-21 and Enemy Fighters	B-1	
Aero 2B-1 Bomb Arming Units	2-13	
Aero 7D, LAU-3A/A, R/L - 2.75		2-283
Aero 27/A Bomb Rack	2-34	
Afterburner, Use of	1-5	
Aggressiveness	1-7	
*AI Radar Capabilities and Limitations	5-16	
*AI Radar, Hi Fix	5-16	
*AI Radar, Spin Scan A	5-16	
*AI Radar, Spin Scan B	5-16	
*AI Radar, Scan Can	5-16	
*AI Radar, Scan Fix	5-16	
*AI Radar, Scan Odd	5-16	
*AI Radar, Scan Odd Modified	5-16	
*Aileron Barrel Roll		5-172
AIM-7 Capabilities and Limitations	1-161	
AIM-7 Firing Delay, F-4B/N and F-4J	1-154	
AIM-7 Gunsight Nose Positioning		1-167
AIM-7 High Altitude Capability	1-162	
AIM-7 Look-Down Capability	1-162	
AIM-7 Low Altitude Capability	1-162	
AIM-7 Missile	1-161	
AIM-7 Missile Envelopes.	1-161	
AIM-7 Performance	1-162	
AIM-7 Procedures.	1-229	
AIM-7 Quick-Shot Requirements		1-169
AIM-7 Splash Zones		1-230
AIM-7D Non-Maneuvering Envelopes		1-233
*AIM-7D/E/E-2 Air-To-Surface Launch Envelope		5-132
AIM-7E ACM Launch Zone	1-165	1-165
*AIM-7E/E-2 ECCM Capabilities	1-27	
AIM-7E/E-2 Air-To-Surface Launch Envelope		1-217
AIM-7 Employment Techniques Against a Maneuvering Target	1-163	
AIM-7E-2 ACM Launch Zone	1-165	1-165
AIM-7E-2 Maneuvering Envelopes.		1-195
AIM-7E-2 Non-Maneuvering Envelopes		1-191
*AIM-7 Status During ECCM.		1-18
AIM-9 Handling Procedures	1-185	
AIM-9 Launch Envelope Discussion	1-183	
AIM-9 Missile	1-170	
AIM-9 Missile Description	1-170	
AIM-9 Missile Performance	1-175	
AIM-9 Missile Time Sequence		1-176
AIM-9 Quick-Shot Requirements		1-187
AIM-9B Firing Exercise Example		1-237
AIM-9B Launch and Safety Parameters		1-235
AIM-9B Launch Zones		1-234
AIM-9B Missile	1-170	1-171
AIM-9B Missile Performance Against Maneuvering Targets	1-175	
AIM-9B Missile Performance Against Non-Maneuvering Targets	1-175	
AIM-9B Procedures	1-231	
AIM-9D/G/H Employment Against Maneuvering Targets	1-178	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
AIM-9D/G/H Missile	1-173	1-174
AIM-9D/G/H Missile Performance Against Maneuvering Targets	1-178	
AIM-9D/G/H Missile Performance Against Non-Maneuvering Targets	1-175	
AIM-9G/H SEAM Missile	1-182	
AIM-9D/G Launch Envelope		1-198
AIM-9D/G Procedures	1-236	
Aim Dot Centering		1-213
*Aimed Fire	5-142	
*Aimed Fire Effectiveness	5-144	
*Air Combat Maneuvering Zones, F-4J/MIG-21F		5-51
*Airborne Intercept Radars	5-16	
*Airborne Lasers	2-1	
*Aircraft, Bomber	5-125	
Aircraft Capabilities	1-3	
Air Combat Maneuvering Angle of Attack Guide		1-4
*Aircraft Comparison Chart		5-18
Aircraft Down Range Travel and Attitude Loss Charts	2-149	2-174
Aircraft Down Range Travel and Altitude Loss for a Release Interval of 0.06 Seconds (Sheet 1)		2-174
Aircraft Down Range Travel and Altitude Loss for a Release Interval of 0.06 Seconds (Sheet 2)		2-175
Aircraft Down Range Travel and Altitude Loss for a Release Interval of 0.06 Seconds (Sheet 3)		2-176
*Aircraft, Fighter	5-17	
Aircraft Maneuverability	1-80	
Aircraft Performance	1-3	
Aircraft System Malfunctions	1-159	
Aircraft-To-Bomb Collisions	2-120	
*Air Defense Operations, Communist-Bloc	5-1	
*Air Defense Procedures (Typical), Estimated	5-6	
*Air Defense System	5-1	
Air Intercept Control, Tactics and	3-23	
Air Intercept Missiles	1-229	
Airplane Speed Restrictions		A-1
Airspeed Conversion (Sheet 1)		2-161
Airspeed Conversion (Sheet 2)		2-162
Airspeed Conversion (Sheet 3)		2-163
Airspeed Conversion Chart	2-146	2-161
Airspeed Error (Level), Release		2-134
Airspeed Error, Release	2-130	
Airspeed Limitations	A-1	
Airspeed Limitations, Sidewinder AIM-9B		A-25
Air-To-Air Employment of MK 4 Gun Pod	1-188	
*Air-To-Air Formations	5-171	
*Air-To-Air Missiles	5-70	
*Air-To-Ground Communications	5-7	
*Air-To-Ground Mission Formations	5-171	
Air-To-Air Missile Targets	1-238	
*Air-To-Surface Anti-Ship Missiles	5-114	
*Air-To-Surface Launch Envelope, AIM-7D/E/E-2		5-132
All Weather Visual Idenfification/ Rendezvous, Night	1-50	
*Alkali Missile		5-72
*Alkali Missile Launch Zones		5-73
Altimeter Lag and Reaction Time	2-127	
Altimeter Lag Charts	2-146	2-165
Altimeter Lag SPC Off		2-165
Altimeter Lag SPC On		2-166
Altitude Profiles		1-227
Altitude Loss Charts, Aircraft Down Range Travel and	2-149	2-174
Altitude Switching		1-162
*Anab Missile		5-78
*Anab Missile Launch Zones		5-79
*AN/ALE-29A Chaff Dispenser	5-165	
*AN/ALE-29A Singles Chaff Switch	5-167	
*AN/ALE-29A Tactical Applications	5-167	
*AN/ALQ-51A Electronic Countermeasures System	5-149	
*AN/ALQ-51A/100 System Test Procedures	5-151	
*AN/ALQ-51A/100 Tactical Applications	5-151	
*AN/ALQ-51A System Operation	5-150	
*AN/ALQ-51A System Test Procedures	5-150	
*AN/ALQ-51A Tactical Applications	5-150	
*AN/ALQ-91A Antenna Coverage and Radar Displays - High and Low Map Mode (F-4J)		5-210
*AN/ALQ-91A Antenna Coverage and Radar Displays - Pulse Doppler Mode (F-4J)		5-211
*AN/ALQ-91A Antenna Coverage and Radar Displays - Pulse Search (F-4J)		5-208
*AN/ALQ-91A Antenna Coverage and Radar Displays - Pulse Track (F-4J)		5-209
*AN/ALQ-91A Antenna Coverage and Radar Displays - Radar In Standby (F-4J)		5-207
*AN/ALQ-91A Antenna Patterns (F-4J)		5-202
*AN/ALQ-91A Countermeasures Set - F-4J	5-198	
*AN/ALQ-91A Equipment Location (F-4J)		5-201
*AN/ALQ-91A Operating Controls (F-4J)		5-204
*AN/ALQ-91A Operation	5-203	
*AN/ALQ-91 Antenna Coverage and Radar Displays - Radar In Search (F-4B/N)		5-199

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*AN/ALQ-91 Antenna Coverage and Radar Displays - Radar In Standby (F-4B/N)		5-197
*AN/ALQ-91 Antenna Coverage and Radar Displays - Radar In Track (F-4B/N)		5-200
*AN/ALQ-91 Antenna Patterns (F-4B/N)		5-193
*AN/ALQ-91 Countermeasures Set - F-4B/N	5-190	
*AN/ALQ-91 Countermeasures System	5-153	
*AN/ALQ-91 Equipment Location (F-4B/N)		5-192
*AN/ALQ-91 Operating Controls (F-4B/N)		5-194
*AN/ALQ-91 Operation	5-195	
*AN/ALQ-91/91A System Test Procedures	5-212	
*AN/ALQ-100 Countermeasures System	5-150	
*AN/ALQ-100 System Operation	5-151	
*AN/ALR-50 System Operation	5-154	
*AN/ALR-50 System Test Procedures	5-154	
*AN/ALR-50 Tactical Applications	5-154	
*AN/ALR-50(V) Missile Warning Receiver	5-153	
*AN/ALR-45 Built-In-Test Procedures	5-163	
*AN/ALR-45 Radar Homing and Warning Receiver	5-159	
*AN/ALR-45 Strobe Displays		5-161
*AN/ALR-45 Tactical Applications	5-163	
*AN/ALR-45 Threat Display Implications		5-160
*Analysis of Enemy Gun Defenses	5-144	
*AN/APG-59 ECCM Features		1-19
*(AN/APG-59), ECCM Features Available	1-18	
*AN/APG-59 ECCM Options and Effects		1-24
*(AN/APG-59), ECCM Tactics	1-23	
*AN/APG-59 Jamming Indication		1-10
AN/APG-59 Radar Acquisition	1-141	
AN/APG-59 Radar Detection and Track	1-136	
AN/APG-59 Radar Search	1-136	
AN/APG-59 Radar Track	1-145	
AN/APQ-72, AN/APG-59, AIM-7 and AIM-9 Capabilities	3-18	
*(AN/APQ-72), ECCM Techniques	1-16	
AN/APQ-72 Radar Acquisition	1-150	
AN/APQ-72 Radar Detection and Track	1-147	
AN/APQ-72 Radar Search	1-147	
AN/APQ-72 Radar Track	1-152	
*AN/APR-25 Strobe Displays		5-157
*AN/APR-25 System Test Procedures	5-159	
*AN/APR-25 Tactical Applications	5-159	
*AN/APR-25 Threat Display Implications		5-156
*AN/APR-25 Warning System	5-155	
*AN/APR-27 Radar Receiving Set	5-152	
*AN/APR-27 System Operation	5-153	
*AN/APR-27 System Test Procedures	5-153	
*AN/APR-27 Tactical Applications	5-153	
AN/APX-76A Displays		1-157
AN/APX-76A Interrogator Equipment Set	1-156	
*AN/APX-76A Interrogator Equipment Set	5-189	
AN/APX-76A Interrogator Set Operation	1-157	
*AN/APX-76A Interrogator Set Operation	5-190	
*AN/APX-76A System Loop-Test	5-190	
*AN/APX-76 Displays		5-191
AN/AWG-10 Radar and Lookout	1-39	
AN/AWW-1, Fuze Function Control Set	2-11	2-12
(AN/AWW-4) F-4J, Fuze Function Control Set	2-11	
AN/TPQ-10 Ground Controlled Radar Bombing	2-102	
Analysis, Error	2-130	
*Angle Deception Jammers	1-12	
*Angle Deception - Pulse Doppler and Pulse, Effects of	1-12	
Angle Error, Dive	2-130	
Angle of Attack Chart, Fuselage	2-146	2-164
Angle of Attack Guide, Air Combat Maneuvering		1-4
*Angle Tracking Deception	5-146	
*Angle Track, Noise Jamming	1-20	
Antenna Beam Coverage, F-4B/N		1-148
*Antenna Correlation Disable Panel	5-158	
*Antennas	5-191, 5-198	
*Anti-Ship Missiles, Air-To-Surface	5-114	
*Anti-Ship Missiles, Comparison of		5-107
*Anti-Ship Missiles, Land Launched	5-121	
*Anti-Ship Missiles, Operations Against	5-126	
*Anti-Ship Missiles, Surface-To-Surface	5-106	
*Anti-Ship Missile Systems	5-106	
*Anti-Ship Missile Terminal Phase Flight Profile Summary		5-127
Application, CONLABS	2-142	
*AOJ From Pulse Doppler Search	1-20	
*AOJ From Pulse Search	1-20	
*Applications of Maneuvers, Tactical	5-182	
AQM-37A Missile Target		1-238

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Armament	3-1	
Armament Control Panel, Auxiliary	2-3	
Armament Safety Override Button	2-3	
Armed Reconnaissance	2-95	
Arming Safety Switch, MK 122 Mod 0	2-13	
Arming Wires	2-40	
Arrangement	xiii	
*AS-5 (Kelt)	5-114	
*AS-1 (Kennel)	5-114	
*AS-6	5-114	
*AS-6 Missile		5-121
*AS-3 (Kangaroo)	5-114	
*AS-2 (Kipper)	5-114	
*Ash Missile		5-81
*Ash Missile Launch Zones		5-82
ASM, Attack Against An	1-218	
ATDS/NTDS Intercept Profiles	1-223	
*Atoll Missile		5-75
*Atoll Missile Launch Zones		5-77
Attack Against An ASM	1-218	
*Attack, IFR	5-128	
Attack, Night	2-104	
Attack Phase	1-210	
Attacks, Beam	1-212	
Attacks, Coordinated	2-120	
Attacks, Forward Hemisphere	1-210, 1-219	
Attacks, Preplanned	1-210	
Attacks, Rear Hemisphere	1-212	
Attacks, Unplanned	1-214	
Attack Tactics	2-96	
*Attack, VFR	5-127	
Attack with Unlike Paraflare Drop Aircraft		2-107
Attitude Director Indicator	2-18	
Attitude Reference Bombing Computer Set	2-18	
*Audio, PRF	5-149	
*Aural Indications	5-155, 5-162	
Automatic Distribution	xiv	
Automatic Track	1-153	
Auxiliary Armament Control Panel	2-3	
AWW-4 Controls	2-13	
AWW-4 Emergency Procedures	2-13	
B		
*Back Net EW/GCI Radar	5-11	
*Back Net/Side Net GCI Radar Combination	5-14	
*Badger	5-125	5-126
*Band Disable Panel	5-158, 5-162	
*Bar Lock GCI Radar	5-10	
*Bar Lock or Back Net/Thin Skin GCI Radar Combination	5-15	
*Bar Lock/Side Net GCI Radar Combination	5-14	
*Bar Lock/Stone Cake or Sponge Cake GCI Radar Combination	5-14	
BARCAP	1-203	
*Barrage Fire	5-142	5-143
*Barrage Jammers	1-8	
*Barrage or Sector Barrage Fire Only (No Aimed Fire)	5-187	
*Barrage or Sector Barrage With Aimed Fire	5-186	
*Barrel Roll	5-170, 5-184	
*Barrel Roll, Aileron		5-172
Barrel Roll Attack		1-18
Barrel Roll Over The Top, High G		1-34
Barrel Roll Underneath, High G		1-35
Base Detonating Fuzes	2-73	
*Basic ECM Threat Tactics	1-15	
Beam Attacks	1-212	
Beam Coverage, F-4B/N Antenna		1-148
Beam Coverage, F-4J Antenna		1-137
*Bear	5-125	5-125
Bibliography	ii	
*Big Bar A and B EW/GCI Radars	5-10	
*Big Mesh EW/GCI Radar	5-10	
*Big Net EW Radar	5-10	
Bogey Positioning For AIM-7 Shot		1-164
Bomb Arming Switch (Nose/Tail Arm Switch)	2-8	
Bomb Arming Units, Aero 2B-1	2-13	
Bomb Control Panel	2-18	
Bomb Control Switch	2-21	
Bomb Fuze Limitations	A-3	
Bomb Fuzing	2-37	
Bomb/Fuze Combinations		2-38
Bomb Rack, Aero 27/A	2-34	
Bomb Release Angle Computer, AN/AJB-3A (F-4B/N)	2-21	
Bomb Release Angle Computer, AN/AJB-7 (F-4J)	2-21	
Bomb Release Button	2-6	
Bomb Release, Emergency	2-14	
Bomb Release, Multiple	2-157	
Bomb Spacing During Multiple Release Charts	2-153	
Bomb-To-Bomb Collisions	2-120	
*Bomber Aircraft	5-125	
Bombing Computer Set, Attitude Reference	2-18	
Bombing, Dive	2-124	
Bombing/Rocketry	2-124	
Boresight Procedures	2-145	
Boresighting	2-145	
BQM-34A Missile Target		1-239
Briefing Form, Pilot's		2-99
Briefing Requirements	1-205	
Broadcast Control	3-2	
Buddy Bombing	2-121	
Buddy Bomb Precautions		2-121
*Button, Challenge Enable	5-189	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
C		
*Camouflage	1-14	
Canopy Code		-54
Capabilities	1-6	
Capabilities, Aircraft	1-3	
*Capabilities and Limitations, AI Radar	5-16	
Capabilities and Limitations, AIM-7	1-161	
*Capabilities, Limitations, and Trends of EW Radars	5-11	
*Capabilities, Limitations, and Trends of GCI Radars	5-15	
*Capabilities, Limitations, and Trends of Height Finding Radars	5-14	
*Capabilities, Limitations, and Trends of Passive Detection Equipment	5-8	
Capability, AIM-7 High Altitude	1-162	
Capability, AIM-7 Look-Down	1-162	
Capability, AIM-7 Low Altitude	1-162	
CAP/DLI Capability, Estimating	3-20	
CAP, Figure Eight	1-206	
CAP, Force	1-206	
CAP Interceptors, Number of	3-19	
CAP, Mig	1-206	
CAP, Missile	1-207	
CAP, Oval	1-206	
CAP Patterns	1-206	
CAP, Rectangular	1-206	
CAP, Specialized	1-206	
CAP Stationing	3-1, 3-20	
CAP Stationing, High-Far	3-24	
CAP Stationing, High-Near	3-24	
CAP Stationing, Long Range	3-25	
CAP Stationing, Low-Far	3-23	
CAP Stationing, Low-Near	3-20	
Captive Flight	1-170	
Carriage and Release Speed Restrictions	2-40	
Carrier Operations	A-3	
CBU-24, -29, -49 Dispenser		2-309
CBU-24, -29, -49 Pattern and Arming	2-151	
CBU Dispensing Procedures	2-15	
Centerline Jettison	2-24	
Centerline MER/TER Adapter	2-34	
Center Station Switch	2-21	
CG Limitations	A-2	
*Chaff	1-3, 1-17, 1-23, 1-27	1-6
*Chaff and Decoys, Forward Fired	1-7	
*Chaff Dispenser, AN/ALE-29A	5-165	
*Chaff/Flare Dispensers	5-164	
*Chaff - Pulse Doppler, Effects of	1-5	
*Chaff - Pulse Doppler, Effects of Forward - Fired	1-7	
*Chaff - Pulse, Effects of	1-5	
*Chaff - Pulse, Effects of Forward-Fired	1-7	
*Challenge Enable Button	5-189	
Change Recommendations	xiv	
Change Symbols	xiv	
*Channel Rotation Plan	1-26	
*Characteristics, Gun System		5-137
*Characteristics, Projectile		5-138
Chart Description	2-146	
Chart, Dive Recovery	2-149	2-167
Charts, Heading Reversal	1-85	1-110
Chart, Instantaneous Radius of Turn	1-84	1-106
Chart Preparation	2-79	
Charts, Altimeter Lag	2-146	2-165
Charts, Combat Performance	1-80	
Charts, Dive Acceleration	2-149	2-170
Charts, Maximum Fragment Envelope	2-150	2-180
Charts, Split-S Maneuver	1-85	1-134
Chart Symbols	2-81	
Checkpoints	2-79	
Checkpoints, Stern Conversion (Pursuit)		1-209
Checks, Cockpit	1-8	
Checks, Post Takeoff	1-8	
*Checks, Premission	5-169	
Checks, SEAM Ground	1-182	
*Circuits, Destruct	5-150, 5-152	
Classic One-On-One Intercept Maneuvers	1-207	
Close Air Intercept Control	3-2	
Close Air Support	2-96	
Close Air Support Command and Control		2-100
Close Combat Techniques	1-8	
Clues For Visually Estimating Range	1-190	
Cluster Bomb Delivery	2-136	
Clutter and Low Level Environments	1-151	
Clutter Environment, Tracking In	1-146, 1-154	
(Coarse Course Direction Phase), Strike Phase	1-228	
Co-channel CW Interference	1-160	
Cockpit Checks	1-8	
Collisions, Aircraft-To-Bomb	2-120	
Collisions, Bomb-To-Bomb	2-120	
Collision Vectoring	3-4	3-9
*Combat Effectiveness Comparison, F-4J/MIG-21F		5-49
Combat Performance Charts	1-80	
Combat Spread Cruising	1-41	
Combat Spread Formation	1-36	
Combat Techniques, Close	1-8	
*Combination Fire	5-142	
*Combined Geometric Plane Maneuvers	5-181	
Communications	3-2	
*Communications, Air-To-Ground	5-7	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*Communications Jamming (Data Link System)	1-26	
*Communications Jamming (Voice)	1-26	
*Communist-Bloc Air Defense Operations	5-1	
*Communist China Capabilities, Limitations, and Trends	5-3	
*Comparison Chart, Aircraft		5-18
*Comparison of Anti-Ship Missiles		5-107
Computation, Example Weight	A-3	
Computations, Sample Problems	2-154	
Computations, Sight Angle	2-154	
Computations, Wind Correction	2-154	
Computer, Dogfight	1-161	
Concept, Loose Deuce	1-36	
Configuration Status	xvi	
Configuration Summary, Performance		3-11
CONLABS Application	2-142	
CONLABS Controls and Indicators (F-4B/N)		2-19
CONLABS Delivery	2-142	2-142
CONLABS Delivery Data	2-153	
CONLABS Delivery Procedure	2-22	
CONLABS Planning	2-143	
CONLABS Planning Profile		2-160
CONLABS Pullup-To-Impact Distance		2-376
CONLABS Release System	2-18	
CONLABS Sample Problem	2-158	
CONLABS Switch	2-21	
Considerations, Tactical	1-76	
Considerations, VID	1-76	
*Continuous Wave Jammers	1-8	
Controller Vectoring to Final Attack Position	3-8	
Control Panel, Auxiliary Armament	2-3	
Control Panel, Multiple Weapons System	2-6	
*Controls and Displays, RHAW	5-155, 5-162	
*Controls and Indicators (F-4B), ECM		5-219
*Controls and Indicators (F-4J), ECM		5-221
Controls and Indicators, Multiple Weapons		2-4
Controls, AWW-4	2-13	
*Controls (F-4J), AN/ALQ-91A Operating		5-204
*Controls (F-4B/N), AN/ALQ-91 Operating		5-194
Controls, Gun Pod	2-15, 2-16	
*Controls, Speech Security Unit	5-215	
*Cooling and Shielding, Engine	1-14	
Coordinated Attacks	2-120	
Coordinated Flight	2-130	
Copies, How to Obtain	xiv	
*Correlation Disable Switch	5-162	
Countering Defensive Pullup		1-16
Countering the High Yo-Yo		1-14
*Countermeasures Set - F-4B/N AN/ALQ-91	5-190	
*Countermeasures Set - F-4J, AN/ALQ-91A	5-198	
*Counter Tactics Against AAA	5-186	
*Counter Tactics Against Both AAA and SAM	5-187	
*Counter Tactics Against SAM	5-184	
Crew Coordination	2-124	
*Crew Responsibility	5-169	
*Cross Fork AAA Acquisition Radar	5-9	
*Cross Legs EW/GCI Radar	5-10	
*Cross Slot EW Radar	5-11	
Cross Turn		1-44
*Cruise Position	5-173	
Cruising, Combat Spread	1-41	
CTU-1A Delivery Container		2-372
*Cuba Capabilities, Limitations, and Trends	5-5	
Curvilinear Tracking	2-127	
CW Interference, Co-channel	1-160	

D

Data Link	1-222	
Data Link Bomb Switch	2-8	
*Data Link, Jamming	1-26	
*(Data Link System), Communications Jamming	1-26	
*Data Link System, Exploitation of	1-26	
*Day LGB Delivery Tactics	2-4	
DC Only Retard Sensing Fuzes (MK 344, MK 376)	2-39	
*Deception, Angle Tracking	5-146	
*Deception Jammers	1-11	
*Deception Jammers, Additional	1-12	
*Deception Jamming	1-17, 1-25, 1-28	
*Deception, Range Tracking	5-146	
*Deception Repeaters	5-146	
Deck Launch Interval	3-20	
*DECM Tactics Against Threat Aircraft	5-188	
*Decoys - Pulse Doppler, Effects of	1-7	
*Decoys - Pulse, Effects of	1-7	
*Defense System, Air	5-1	
Defensive Maneuvering	1-29	
Defensive Positioning	3-4	3-5
Defensive Pullup, Countering		1-16
Defensive Roll Away		1-33
Defensive Spiral		1-32
Defensive Tactics, Loose Deuce		1-59
Defensive Zone Engagements	1-68	
Defensive Zone, Section		1-68
Delivery Considerations, Level	2-133	
Delivery Data, CONLABS	2-153	
Delivery Data Description	2-150	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page Text	Illus.
Delivery Data Sample From NAVAIR 01-16-1T		2-155
Delivery, Dive		2-126
Delivery, Level		2-133
Delivery Options	2-39	
Delivery Procedure, CONLABS	2-22	
*Delivery Tactics, AC-130 Gun Ship	2-4	
*Delivery Tactics, Day LGB	2-4	
*Delivery Tactics, Laser Guided Bomb	2-4	
*Delivery Tactics, Night LGB	2-4	
*Delivery Tactics, Pave Knife	2-4	
*Delivery Tactics, Pave Nail	2-4	
*Delivery Tactics, Pave Way	2-4	
*Destruct Circuits	5-150, 5-152	
Destructor Delivery	2-138	
Destructor MK 36/40 (DST) Arming and Firing System		2-50
*Detection Equipment, Passive	5-8	
*Detection, Passive	5-8	
Detection, Side Lobe		1-141
Detection, Target	1-136, 1-147	
*Development, Fighter	5-17	
Diagrams, Symmetrical Flight V-N	1-83	1-83
Disengagement Techniques	1-76	
*Dispense Panel, Flare/Chaff Singles	5-166	
*Dispenser, AN/ALE-29A Chaff	5-165	
Dispenser Release From MER/TER	2-15	
*Dispensers, Chaff/Flare	5-164	
Dispensing Procedures CBU	2-15	
*Display Implications, AN/APR-25 Threat		5-156
*Displays, AN/ALR-4 Strobe		5-161
*Displays, AN/APR-25 Strobe		5-157
*Displays, AN/APX-76		5-191
Displays, AN/APX-76A		1-157
*Displays, ECCM		1-21
*Displays (F-4B/N), FO(2) and FO(9) Passive Video		5-196
*Displays (F-4J), FO(2) and FO(9) Passive Video		5-205
*Displays - High and Low Map Mode (F-4J), AN/ALQ-91A Antenna Coverage and Radar		5-210
*Displays - Pulse Doppler Mode (F-4J), AN/ALQ-91A Antenna Coverage and Radar		5-211
*Displays - Pulse Search (F-4J), AN/ALQ-91A Antenna Coverage and Radar		5-208
*Displays - Pulse Track (F-4J), AN/ALQ-91A Antenna Coverage and Radar		5-209
*Displays - Radar In Search (F-4B/N), AN/ALQ-91 Antenna Coverage and Radar		5-199
*Displays - Radar In Standby (F-4B/N), AN/ALQ-91 Antenna Coverage and Radar		5-197
*Displays - Radar In Standby (F-4J), AN/ALQ-91 Antenna Coverage and Radar		5-207
*Displays - Radar In Track (F-4B/N), AN/ALQ-91 Antenna Coverage and Radar		5-200
*Displays, RHAW Controls and	5-155, 5-162	
*Disposition of Fighters	5-22	
*Disposition of GCI Radars	5-15	
*Disposition of Height Finding Radars	5-13	
Dive Acceleration (Sheet 1)		2-170
Dive Acceleration (Sheet 2)		2-171
Dive Acceleration (Sheet 3)		2-172
Dive Acceleration Charts	2-149	2-170
Dive Angle Error	2-130	
Dive Angle Error (Dive Delivery)		2-129
Dive Angle/Horizontal Distance	2-149	2-173
Dive Bombing	2-124	
Dive Delivery		2-126
Dive Delivery Considerations	2-125	
Dive Or Straight-and-Level Delivery Option	2-42	
Dive Recovery	2-127	
Dive Recovery (Sheet 1)		2-167
Dive Recovery (Sheet 2)		2-168
Dive Recovery (Sheet 3)		2-169
Dive Recovery Chart	2-149	2-167
*Division Formation Rationale	5-179	
Division Formations	1-76	
*Division Formations and Maneuvers	5-179	
Division Tactical Principles	1-79	
Doctrine, Tactical	1-7	
Dogfight Computer	1-161	
Drag Index and Weight		A-6
Drag Index and Weight Table	A-2	
D R Navigation	2-79	
Dual Fuzing	2-41	

E

E-2A/F-4 Team Stationary		3-25
Early Bursts	2-40	
*Early Warning and Surveillance Radars	5-9	
Early Warning Radius	3-19	
*ECCM Capabilities, AIM-7E/E-2	1-27	
*ECCM Displays		1-21
*ECCM Features, AN/APG-59		1-19
*ECCM Features Available (AN/APG-59)	1-18	
*ECCM Options and Effects, AN/APG-59		1-24
*ECCM Procedures and Tactics	1-16	
*ECCM Tactics (AN/APG-59)	1-23	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*ECCM Techniques (AN/APQ-72	1-16	
*ECM Audio Control Panel	5-151	
*ECM Audio Knob	5-158, 5-162	
*ECM Controls and Indicators (F-4B)		5-219
*ECM Controls and Indicators (F-4J)		5-201
*ECM Priorities	1-15	
*ECM, Spurious Response	1-14	
*ECM Threat Tactics, Basic	1-15	
*ECM, Types and Effects of	1-3	
*ECM Warning Light Panel (Front)	5-151	
*ECM Warning Light Panel (Rear)	5-150	
*ECM Warning Lights Panel	5-153, 5-154, 5-158, 5-162	
Effect of Releasing in a Bank		2-131
Effects of Arcing		1-26
*Effects of Chaff - Pulse	1-5	
*Effects of Chaff - Pulse Doppler	1-5	
*Effects of Decoys - Pulse	1-7	
*Effects of Decoys - Pulse Doppler	1-7	
*Effects of Forward - Fired Chaff - Pulse	1-7	
*Effects of Forward - Fired Chaff - Pulse Doppler	1-7	
*Effects of Gate Stealer - Pulse	1-12	
*Effects of Gate Stealer - Pulse Doppler	1-12	
*Effects of Noise and Chaff - Pulse	1-11	
*Effects of Noise and Chaff - Pulse Doppler	1-11	
*Effects of Noise Jammers - Pulse Doppler	1-8	
*Effects of Noise Jamming - Pulse	1-8	
*Effects of Repeaters - Pulse	1-12	
*Effects of Repeaters - Pulse Doppler	1-12	
*Effectiveness, Aimed Fire	5-144	
*Effectiveness, Sector Barrage	5-144	
*Effects of Angle Deception - Pulse Doppler and Pulse	1-12	
Ejector Racks MER/TER, Multiple and Triple	2-34	
Electric Bomb Fuze System Operation	2-13	
Electric Fuze Operation	2-39	
Electric Fuzes	2-39	
*Electronic Equipment	5-7	
EMCON, Weather and	3-20	
Emergency Bomb Release	2-14	
Emergency Jettison	2-29	
Emergency Procedures, AWW-4	2-13	
Emergency Release Button, External Stores	2-23	
Employment of CAP or DLI, Factors Affecting	3-18	
*Employment, Capabilities, and Limitations of Fighter Aircraft	5-22	
Employment Techniques Against A Maneuvering Target, AIM-7	1-163	
Endurance Versus Altitude		3-17
Enemy Threat	3-19	
*Energy Comparison, F-4/MIG-17		5-24
Energy Comparison, F-4/MIG-21		5-35
Energy Conversion of Altitude and Fuel		3-16
Energy Conversion of Speed and Fuel		3-13
*Energy Diagram, Flagon A		5-63
*Energy Diagram, Flogger		5-69
*Energy Diagram, FOXBAT		5-55
*Energy Diagram, MIG-19		5-29
*Energy Diagram, MIG-21F		5-33
*Energy Diagram, MIG-21H/J		5-34
Energy Maneuverability	1-80	
Engaged and Fire Fighter Objectives	1-58	
Engaged Maneuvering	1-21	
(Engaged), Radar Tactics	1-53	
Engagement	1-5	
Engagements, Defensive Zone	1-68	
Engagement, Visual	1-60	
Engagement, Visual	1-163	
Engaging Multiple Bogeys	1-76	
*Engine Cooling and Shielding	1-14	
Entry, Pop-Up	2-125	
Envelope Discussion, AIM-9 Launch	1-183	
Envelopes, AIM-7E-2 Maneuvering		1-195
Envelopes, AIM-7E-2 Non-Maneuvering		1-191
Envelopes, AIM-7 Missile	1-161	
*Equipment, Electronic	5-7	
*Equipment Subject to Electromagnetic Countermeasures, F-4		1-2
*Estimated Air Defense Procedures (Typical)	5-6	
Error Analysis	2-130	
Escort, Helicopter	2-101	2-103
*Estimated ECM Carrying Capabilities For Threat-Bomber and Fighter Aircraft		1-4
*Estimated I-band Chaff Threat		1-5
*Estimated SA-N-1 Intercept Envelopes Against Radially Incoming Targets	5-104	
Estimating CAP/DLI Capability	3-20	
Estimating Range, Clues for Visually	1-190	
Estimation of Range, Visual		1-189
*Evasive Maneuvers, Single Airplane	5-170	
*EW/GCI Radar, Back Net	5-11	
*EW/GCI Radars, Big Bar A and B	5-10	
*EW/GCI Radar, Big Mesh	5-10	
*EW/GCI Radar, Cross Legs	5-10	
*EW Radar, Big Net	5-10	
*EW Radar, Cross Slot	5-11	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*EW Radar, Moon Cone	5-9	
*EW Radar, Moon Face	5-9	
*EW Radars, Capabilities, Limitations, and Trends of	5-11	
*EW Radars, Knife Rest B/C	5-9	
*EW Radars, Moon Mat 1 and 2	5-10	
*EW Radars, Spoon Rest A and B	5-9	
*EW Radars, Strength and Disposition of	5-11	
*EW Radar, Tall King	5-9	
Example Weight Computation	A-3	
*Expected Soviet Bomber ECM/IRCM Capabilities Against F-4 Equipment		1-3
*Exploitation of the Data Link System	1-26	
Extension	1-21	
Extension Errors That Result In Arcing		1-25
External Stores	A-3	
External Stores Emergency Release Button	2-23	
External Stores Limitations		A-8
External Tanks Jettison Switch	2-24	
F		
*F-4 Equipment Subject to Electromagnetic Countermeasures		1-2
*(F-4B), ECM Controls and Indicators		5-219
F-4B Maneuverability Diagram		1-88
F-4B/N and F-4J AIM-7 Firing Delay	1-154	
F-4B/N Antenna Beam Coverage		1-148
F-4J Antenna Beam Coverage		1-137
*(F-4J), ECM Controls and Indicators		5-221
F-4J Maneuverability Diagram		1-96
*F-4J/MIG-21F Air Combat Maneuvering Zones		5-51
*F-4J/MIG-21F Combat Effectiveness Comparison		5-49
*F-4J/MIG-21F Performance Comparison Combat Time		5-48
*F-4J/MIG-21F Performance Comparison Conversion Time		5-47
*F-4J/MIG-21F Performance Comparison Maximum Load Factor		5-44
*F-4J/MIG-21F Performance Comparison Maximum Turn Rate		5-45
*F-4J/MIG-21F Performance Comparison Sustained Turn Load Factor		5-42
*F-4J/MIG-21F Performance Comparison Sustained Turn Rates		5-43
*F-4J/MIG-21F Performance Comparison - Unloaded Acceleration		5-41
*F-4/MIG-17 Energy Comparison		5-24
*F-4/MIG-21 Energy Comparison		5-35
*F-4J Versus MIG-21F ACM Performance Comparison	5-39	
*F-4J VS. MIG-21F Tactics	5-50	
Factors Affecting Employment of CAP or DLI	3-18	
*Fansong Radar	5-84	
*Farmer E, MIG-19		5-27
*Farmer, MIG-19	5-27	
*Fault Indicators	5-190	
*Fiddler, TU-28	5-65	5-66
*Field of Fire		5-140
Field of Maneuver		1-11
Field of View		1-38
*Fighter Aircraft	5-17	
*Fighter Aircraft, Employment, Capabilities, and Limitations of	5-22	
*Fighter Development	5-17	
*Fighters, Disposition of	5-22	
Fighter Versus Fighter Maneuvering	1-11	
*Fighter Weapon Systems	5-17	
Fighting Zone, Optimum		1-6
Figure Eight CAP	1-206	
*Fire, Aimed	5-142	
*Fire, Barrage	5-142	5-143
*Fire, Combination	5-142	
*Fire Controls	5-139	
*Fire, Sector Intercept	5-142	5-143
*Firebar, YAK-28	5-64	5-65
Firebomb Delivery	2-136	
Firebomb Indicator, MK 13 MOD 0		2-54
Firing Delay, F-4B/N and F-4J AIM-7	1-154	
Firing Exercise Examples, AIM-9B		1-237
Firing Exercise Voice Procedures		1-232
Firing Techniques	1-189	
*Fishbed F, MIG-21		5-30
*Fishbed, MIG-21	5-30	
*Fishpot B, SU-9		5-59
*Fishpot, SU-9	5-59	
*Fitter, SU-7	5-57	
*Fitter, SU-7A		5-57
*Flagon A Energy Diagram		5-63
*Flagon A Performance		5-62
*Flagon A, SU-11A	5-60	5-61
Flaps, Use of	1-5	
Flare Warhead (MK 33)	2-77	
*Flare/Chaff Singles Dispense Panel	5-166	
*Flares, Infrared	1-14	
*Flat Face Surveillance Radar	5-10	
Flight Performance Data	3-10	
Flight Strength Diagram	A-2	A-5
Flight Tactics	2-95	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*Flogger	5-70	5-67
*Flogger Energy Diagram		5-69
*Flogger Speed/Altitude Envelope		5-68
Force CAP	1-206	
Formation, Combat Spread		1-36
Formation, Loose Deuce Squared		1-77
Formation, Tactical Wing		1-78
*Formations	5-184	
*Formations, Air-to-Air	5-171	
*Formations, Air-to-Ground Mission	5-171	
*Formations and Maneuvers, Division	5-179	
*Formations and Maneuvers, Section	5-171	
Formations, Division	1-77	
*Formations, Section	5-171	
*FO(2) and FO(9) Passive Video Displays (F-4B/N)		5-196
*FO(2) and FO(9) Passive Video Displays (F-4J)		5-205
*Forward-Fired Chaff and Decoys	1-7	
Forward Hemisphere Attacks	1-210	
Forward Hemisphere Attacks	1-219	
*Foxbat Energy Diagram		5-55
*Foxbat, MIG-23	5-53	5-54
Fragment Envelope/Safe Release Interval		2-122
Free Fighter Objectives, Engaged and	1-58	
*Frequency Band Designations		5-2
*Frequency Spectrum, Radar		5-147
*Fresco C and D, MIG-17		5-23
*Fresco, MIG-17	5-22	
Fuel Considerations	3-3	
Fuel Management	1-5	
Functioning Delay Option	2-42	
*Fundamental Maneuvering Recommendations	5-179	
Fuselage Angle of Attack		2-164
Fuselage Angle of Attack Chart	2-146	2-164
Fuze Arming	2-37	
Fuze Extension (Daisy cutter), M1A1		2-49
Fuze Function Control Set AN/AWW-1	2-11	2-12
Fuze Function Control Set (AN/AWW-4)	2-11	
Fuze Function Control Sets		2-12
Fuze Functioning	2-37	
Fuze, MK 346		2-59
Fuze, M907 E1/E2		2-61
Fuze Operation, Electric		2-39
Fuze Safety and Reliability Considerations	2-41	
Fuze Selection	2-44	
Fuze System Operations, Electric Bomb	2-13	
Fuzes, Electric	2-39	
Fuzes, Mechanical	2-37	
Fuzes, Mechanical Time	2-72	
Fuzes, Rocket	2-72	
Fuzes, (VT) Proximity	2-72	
Fuzing	2-120	
Fuzing and Fuze Limitations	2-37	
Fuzing, Bomb	2-37	
Fuzing, Dual	2-41	

G

	Page No. Test	Illus.
*Gainful Missile	5-102	
*Gammon Missile	5-102	
*Ganef Missile	5-101	
*Gate Stealer - Pulse Doppler, Effects of	1-12	
*Gate Stealer - Pulse, Effects of	1-12	
*GCI Radar, Bar Lock	5-10	
*GCI Radar Combination, Back Net/Side Net	5-14	
*GCI Radar Combination, Bar Lock or Back Net/Thin Skin	5-15	
*GCI Radar combination, Bar Lock/Side Net	5-14	
*GCI Radar Combination, Bar Lock/Stone Cake or Sponge Cake	5-14	
GCI Radar Combination, Moon Face or Moon Cone/Rock Cake	5-15	
*GCI Radar Combination, Tall King/Side Net	5-15	
*GCI Radar Combination, Token or Cross Legs/Rice Cup	5-15	
*GCI Radars, Capabilities, Limitations, and Trends of	5-15	
*GCI Radars, Disposition of	5-15	
*GCI Radar, Strike Out	5-10	
*GCI Radar, Token	5-10	
Geometry, Intercept	1-210	1-211
Glossary of Terms and Abbreviations	iv	
*GOA Missile	5-97	
Gross Weight Correction	2-146	
*Ground Controlled Intercept Radars	5-14	
*Ground Lasers	2-1	
*Guidance Modes, SAM	5-180	
*Guidance System, Missile	5-121	
*Guideline Missiles	5-90	
*Guideline Mod I Missile Performance		5-91
Guidelines for Delivery Mode Options	2-44	
Guidelines, Section	1-60	
*Gun and Fire Control Systems	5-137	
*Gun Defenses, Analysis of Enemy	5-144	
Gun Firing Procedures	2-17	
Gun/Missile Arm Switch and Weapon READY Light	2-16	
Gun Pod, Air-To-Air Employment of MK 4	1-188	
Gun Pod Controls	2-15, 2-16	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*Gun Ship System, AC-130	2-2	
*Gun System Characteristics		5-137
*Gun Systems	5-137	
Gunnery Equipment	2-15	
Gunsight Nose Positioning, AIM-7		1-167
Gunsight Tracking	1-188	1-188
Guns Switch	2-8, 2-16	
H		
Handling Procedures, AIM-9	1-185	
*Hard Turn	5-171	5-178
HE GP MK 1 All Mods	2-73	
HE GP M151	2-73	
Heading Reversal Charts	1-85	1-110
Head-on Attack, VID to		1-47
Head-On or Forward Quarter Approach Geometry		1-226
Head-on Pass	1-21	
Head-On Pass Technique		1-23
*Heat Sources, Modulated	1-14	
HEAT/APERS (MK 32)	2-77	
HEAT (MK 5)	2-77	
Height Error (Level), Release		2-134
Height Error, Release	2-130	
*Height Finding Radar, Rice Cup	5-13	
*Height Finding Radar, Rock Cake	5-13	
*Height Finding Radars	5-13	
*Height Finding Radars, Capabilities, Limitations, and Trends of	5-14	
*Height Finding Radars, Disposition of	5-13	
*Height Finding Radar, Side Net	5-13	
*Height Finding Radar, Sponge Cake	5-13	
*Height Finding Radar, Stone Cake	5-13	
*Height Finding Radar, Thin Skin	5-13	
Helicopter Escort	2-101	
*Hi Fix AI Radar	5-16	
High Altitude Capability, AIM-7	1-162	
High Altitude Raids, Medium and	3-7	
High Altitude Supersonic Targets	1-219	
High Altitude Tactics	1-219	
High Angle Strafing Techniques	2-139	
High Explosive Frag (MK 63)	2-77	
High Explosive GP	2-73	
High G Barrel Roll Over The Top		1-34
High G Barrel Roll Underneath		1-35
High-Far CAP Stationing	3-24	
High-Near CAP Stationing	3-24	
High Rudder Reversal		1-28
High Speed Characteristics	1-3	
High Yo-Yo		1-13, 1-14
H-M Diagram		1-104
H-M (Height-Mach) Diagrams	1-84	
*HOJ From Automatic Track	1-20	
*Horizontal Weave	5-173	
How to Obtain Copies	xiv	
I		
*IFR Attack	5-128	
*IFF Audio Control Knob	5-189	
*IFF Ground Test Switch	5-190	
In-Place Turn		1-43
In-Trail Tactics (All Weather)	1-220	
Incorrect Use of Collision Course Vectoring		3-6
*Indications, Aural	5-155, 5-162	
Indicator, Attitude Director	2-18	
*Indicators, Fault	5-190	
Inflight Rehoming (MER/TER)	2-8A, 2-14	
Inflight Sight Check	2-146	
*Infrared Countermeasures (IRCM)	1-14	
*Infrared Flares	1-14	
Impact Firing Rocket Fuzes	2-72	
Impact Pattern, Rockeye II	2-153	
Instantaneous Radius of Turn Chart	1-84	1-106
*Intelligence	B-1	
Intercept Control, Close Air	3-2	
*Intercept Envelope Plan View, SA-3		5-100
*Intercept Envelope, SA-3		5-99
Intercept Geometry	1-210	1-211
Intercept Maneuvers, Classic One-On-One	1-207	
*Intercept Operations	5-5	
*Intercept Trajectory - Split-S Target Maneuver		5-183
Interceptor/Air Controller Team Concept, Advantages of	3-21	
Interceptor Control Techniques	3-1	
Interceptors, Number of CAP	3-19	
Intercept Procedures	3-6	
Intercept Profiles, ATDS/NTDS	1-223	
Intercept Terminology		1-208
*Interface Capability	5-150	
Interference, Co-channel CW	1-160	
*Integrated Control Panel	5-150, 5-152, 5-154, 5-166	
Interim Change Summary	xiv	
Interim Change Summary		Flyleaf 1
Interrogator Equipment Set, AN/APX-76A	1-156	
*Interrogator Equipment Set, AN/APX-76A	5-189	
*Interrogator Set Control Panel	5-189	
Interrogator Set Operation, AN/APX-76A	1-157	
*Interrogator Set Operation, AN/APX-76A	5-190	
Interval Switch	2-11	
Introduction	1-2	
*(IRCM), Infrared Countermeasures	1-14	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
J		
*J Track	1-23	
*Jammers, Angle Deception	1-12	
*Jammers, Barrage	1-8	
*Jammers, Continuous Wave	1-8	
*Jammers, Deception	1-11	
*Jammers, Noise	1-8	
*Jammers, Pulse Doppler, Effects of Noise	1-8	
*Jammers, Spot	1-8	
*Jammers, Swept	1-8	
*Jamming Data Link	1-26	
*Jamming, Deception	1-17, 1-25, 1-28	
*Jamming Indications, AN/APG-59		1-10
*Jamming, Noise	1-16, 1-23, 1-27	1-9
*Jamming - Pulse, Effects of Noise	1-8	
Jettison Controls		2-25
Jettison Select Switch	2-24	
Jettison Switch, External Tanks	2-24	
Jettison System	2-23	
*Jinking	5-171	
K		
*(Kangaroo), AS-3	5-114	
*Kangaroo Missile		5-119
*(Kelt), AS-5	5-114	
*Kelt Missile		5-120
*(Kennel), AS-1	5-114	
*Kennel Missile		5-117
(Killer), Tactical Wing	1-78	
*(Kipper), AS-2	5-114	
*Kipper Missile		5-118
*Knife Rest A EW Radars, RUS-2, RUS Type, and Hi Dumbo	5-9	
*Knife Rest B/C EW Radars	5-9	
*Knob, ECM Audio	5-158, 5-162	
*Knob, IFF Audio Control	5-189	
*KY-28 Control Panel	5-216	
*KY-28, Speech Security Unit	5-215	
*KY-28 Tactical Applications	5-217	
L		
LABS Light	2-22	
LABS Mode Switch	2-21	
LABS Timer	2-22	
Lag Pursuit	1-12	
Lag Pursuit Roll		1-19
*Land Launched Anti-Ship Missiles	5-121	
Landing Gear Handle Safety Switch	2-28	
Landing Gear Scissors Switch	2-28	
Laser Beam Properties	2-115	
*Laser Guided Bomb Delivery Tactics	2-4	
Laser Guided Bomb Delivery Tactics	2-116	
*Laser Guided Bomb Miss Distance		2-3
Laser Guided Bomb System	2-115	
Laser Guided Bombs	2-115	
Laser Mission	2-115	
Laser Mission Considerations	2-116	
Laser Target Designator	2-115	
Laser Target Designator Systems	2-116	
Laser Theory	2-115	
*Lasers, Airborne	2-1	
*Laser Target Designator System	2-1	
*Lasers, Ground	2-1	
Last Ditch Maneuvering	1-29	
LAU-10/A Rocket Launcher - 50 Zuni		2-296
LAU-17A Pylon Adapter (TER Adapter)	2-34	
LAU-17/A Wing Missile Pylon (Inboard)	2-34	
LAU-32A/A, -32B/A, -56/A, -68/A Rocket Launchers		2-284
LAU-33A/A Rocket Launcher		2-297
Launch and Safety Parameters, AIM-9B		1-235
Launch Envelope, AIM-7E/E-2 Air-To-Surface		1-217
Launch Envelope, AIM-9D/G		1-198
Launch Envelope Discussion, AIM-9	1-183	
Launch Phase	1-170	
Launch Zone, ACM	1-164	
Launch Zones, AIM-9B		1-234
*Launch Zones, Alkali Missile		5-73
*Launch Zones, Anab Missile		5-79
*Launch Zones, Ash Missile		5-82
*Launch Zones, Atoll Missile		5-77
Lead Pursuit Vectoring	3-5	3-7
Level Delivery		2-133
Level Delivery Considerations	2-133	
Level Performance Versus Configuration		3-12
Limitations, Acceleration	A-2	A-4
Limitations, AIM-7 Capabilities and	1-161	
Limitations, Airspeed	A-1	
Limitations, Bomb Fuze	A-3	
Limitations, CG	A-2	
Limitations, External Stores		A-8
Limitations of Pulse Doppler Radar	3-4	
Limitations of Pulse Radar	3-3	
Limitations, RF Transmission	A-3	
Limitations, Sidewinder AIM-9B Airspeed		A-25
Limitations, Weight	A-2	
Logistics	3-20	
Long Range CAP Stationing	3-25	
Look-Down Capability, AIM-7	1-162	
Lookout Doctrine	1-7	
Lookout Responsibility, Visual		1-37
Loose Deuce Concept	1-36	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Loose Deuce Defensive Tactics		1-69
Loose Deuce Offensive Tactics		1-62
Loose Deuce Squared	1-77	
Loose Deuce Squared Formation		1-77
Loose Deuce Tactics	1-36	
Loose Deuce Turns	1-42	
Loose Deuce UHF Transmissions	1-59	
Loose Deuce Visual Responsibilities	1-60	
Low Altitude/High Velocity Targets	1-215	
Low Altitude/Low Velocity Target	1-215	
Low Altitude	1-214	
Low Altitude Capability, AIM-7	1-162	
Low Altitude Raids	3-6	
Low Altitude Search Over Land	1-150	
Low Altitude Search Over Water	1-149	
Low Altitude Targets	1-214	
Low Angle Strafing Techniques	2-138	
*Low Blow Radar	5-95	
Low Energy Reversal	1-22	
Low-Far CAP Stationing	3-23	
Low Level Environments, Clutter and	1-151	
Low-Near CAP Stationing	3-20	
Low Yo-Yo		1-17
M		
Malfunction, Missile	1-160	
Malfunction, Radar	1-158	
Malfunction, Aircraft System	1-159	
Malfunction, System	1-158	
Maneuver Charts, Split-S	1-85	1-134
*Maneuver Feasibility	5-170	
Maneuver, Field of		1-11
*Maneuver, Intercept Trajectory - Split-S Target		5-183
*Maneuver Rationale	5-170	
Maneuver, Roll-Away		1-20
*Maneuver, Split-S		5-174
*Maneuver, Split-S Spiral		5-176
*Maneuvers	5-170, 5-179	
*Maneuvers, Combined Geometric Plane	5-181	
Maneuvers, Prohibited	A-2	
*Maneuver, Spiral		5-175
*Maneuvers, Section	5-173	
*Maneuvers, Single Geometric Plane	5-180	
*Maneuvers, Tactical Application of	5-182	
Maneuverability, Aircraft	1-80	
Maneuverability Diagram, F-4B		1-88
Maneuverability Diagram, F-4J		1-96
Maneuverability Diagrams	1-83	
Maneuverability Energy	1-80	
Maneuvering, Defensive	1-29	
Maneuvering, Engaged	1-21	
Maneuvering Envelopes, AIM-7E-2		1-195
Maneuvering, Fighter Versus Fighter	1-11	
Maneuvering, Last Ditch	1-29	
Maneuvering, One Versus One Offensive	1-12	
*Maneuvering Recommendations, Fundamental	5-179	
Maneuvering Target, AIM-7 Employment Techniques Against a	1-163	
Maneuvering Targets, AIM-9B Missile Performance Against	1-175	
Maneuvering Targets, AIM-9D/G/H Employment Against	1-178	
Maneuvering Targets, AIM-9D/G/H Missile Performance Against	1-178	
Maneuvering, Theory of	1-11	
Maneuvering, VID	1-45	
Manual Acquisition	1-151	
Manual and Semi-Manual Track	1-153	
*Manual Track, Pulse	1-23	
*Manual Track, Pulse Doppler	1-23	
Master Arm Switch or Weapons Switch (F-4B)	2-6	
Maximum Fragment Envelope Charts	2-150	2-180
Maximum Launch Range		1-177
Maximum Power Climb		3-15
Mechanical Fuzes	2-37	
Mechanical Time Fuzes	2-72	
Mechanical Time Fuzes (MK 193 MOD 0	2-73	
Medium Altitude Subsonic Targets	1-218	
Medium Altitude Tactics	1-218	
Medium and High Altitude Raids	3-7	
MER/TER Release Procedures	2-14	
Mig CAP	1-206	
*MIG-19 Advantages	5-30	
*MIG-19 Disadvantages	5-30	
*MIG-19 Energy Diagram		5-29
*MIG-19 Farmer	5-27	
*MIG-19 Farmer E		5-27
*MIG-17 Advantages	5-26	
*MIG-17 Disadvantages	5-27	
*MIG-17 Fresco	5-22	
*MIG-17 Fresco C and D		5-23
*MIG-21 Advantages	5-39	
*MIG-21 and Enemy Fighters, Aerial Combat Between	B-1	
*MIG-21 Disadvantages	5-39	
*MIG-21F Energy Diagram		5-33
*MIG-21 Fishbed	5-30	
*MIG-21 Fishbed F		5-30
*MIG-21H/J Energy Diagram		5-34
*MIG-23 Foxbat	5-53	5-54
Mini-Boresight Plate	2-146	2-147

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Minimum Authorized Arming Time	2-41	
Minimum Release Altitude	2-41	
*MISCAP, Radar Coverage		5-129
*MISCAP, Visual Coverage		5-128
*Miss Distance, Laser Guided Bomb		2-3
Missile, AIM-7	1-161	
Missile, AIM-9	1-170	
Missile, AIM-9B	1-170	1-171
Missile, AIM-9D/G/H	1-173	1-174
*Missile, Air-to-Air	5-70	
*Missile Alert Receivers	5-152	
*Missile, Alkali		5-72
*Missile, Anab		5-78
*Missile, Ash		5-81
*Missile, AS-6		5-121
*Missile, Atoll		5-75
Missile CAP	1-207	
Missile Description, AIM-9	1-170	
Missile Envelopes, AIM-7	1-161	
*Missile, Gainful	5-102	
*Missile, Gammon	5-102	
*Missile, Ganef	5-101	
*Missile, GOA	5-97	
*Missile Guidance Systems	5-121	
Missile Jettison Knob, Selective	2-24	
*Missile, Kangaroo		5-119
*Missile, Kelt		5-120
*Missile, Kennel		5-117
*Missile, Kipper		5-118
Missile Malfunction	1-160	
Missile Performance, AIM-9	1-175	
*Missile Performance, SA-3		5-98
Missile Pylon (Inboard), LAU-17/A Wing	2-34	
*Missile, Samlet		5-122
*Missile, Scrubber		5-108
*Missile, Shaddock		5-111
*Missile, SS-N-7		5-113
*Missile, SS-N-10		5-116
*Missiles, Surface-to-Air	5-84	5-92
*Missile, Styx		5-110
*Missile Systems, Anti-Ship	5-106	
Missile Targets, Air-to-Air	1-238	
*Missile Terminal Phase Flight Profile Summary, Anti-Ship		5-127
Missile Time Sequence, AIM-9		1-176
Missile Trigger Switch	2-16	
Missile, Air Intercept	1-229	
Missiles - Free Environment	1-42	
*Missiles, Guideline	5-90	
*Missile, SS-N-9		5-115
Mission Planning Considerations	2-86	
Mission Planning Index	2-86	
Mission Planning Index (Sheet 1)		2-87
Mission Planning Index (Sheet 2)		2-88
Mission Planning Index (Sheet 3)		2-89
Mission Planning Index (Sheet 4)		2-90
Mission Planning Index (Sheet 5)		2-91
Mission Planning Index (Sheet 6)		2-92
Mission Planning Index (Sheet 7)		2-93
Mission Planning Index (Sheet 8)		2-94
Mission, Special	2-101	
MK 4 Gun Pod		2-351
MK 4 Gunpod, Air-to-Air Employment of	1-188	
MK 5, HEAT	2-77	
MK 12 MOD 0 Smoke Tank		2-373
MK 13 MOD 0 Fire Bomb Initiator		2-54
MK 24	2-73	
MK 24 Flare		2-364
MK 32, HEAT/APERS	2-77	
MK 34	2-77	
MK 36/40 (DST) Arming and Firing System, Destructor		2-50
MK 39 Connector	2-13	
MK 40 DST (1000)		2-214
MK 43 Target Detecting Device		2-67
MK 45 Paraflare		2-368
MK 67	2-77	
MK 76 MODS 4 & 5 Practice Bomb (25 lb.)		2-261
MK 77 Fire Bomb		2-256
MK 81 LDGP Bomb (250 lb.)		2-228
MK 81 Snakeye Bomb (250 lb.)		2-186
MK 82 Laser Guided Bomb		2-252
MK 82 LDGP		2-236
MK 82 LDGP Bomb (500 lb.)		2-236
MK 82 Snakeye Bomb (500 lb.)		2-199
MK 83 LDGP Bomb (1000 lb.)		2-244
MK 86 Practice Bomb (250 lb.)		2-229
MK 87 Practice Bomb (500 lb.)		2-237
MK 88 Practice Bomb (1000 LB)		2-245
MK 89 Practice Bomb (56 lb.)		2-275
MK 106 MOD 4 Practice Bomb (5 lb.)		2-268
MK 122 Mod 0 Arming Safety Switch	2-13	
MK 339 Mod 0 Fuze		2-62
MK 344/376 Fail Fuze		2-55
MK 346 Fuze		2-59
MK 347 Nose Fuze		2-47
*Modified Vertical-S	5-171	
*Mod I Missile Performance, Guideline		5-91
Mod 0 Fuze, MK 339		2-62
*Modulated Heat Sources	1-14	
*Moon Cone EW Radar	5-9	
*Moon Face EW Radar	5-9	
*Moon Face or Moon Cone/Rock Cake GCI Radar Combination	5-15	
*Moon Mat 1 and 2 EW Radars	5-10	
MQM-74A Missile Target		1-240
MQM-74A Performance		1-241
Multiple and Triple Ejector Racks MER/TER	2-34	
Multiple Bogeys, Engaging	1-76	
Multiple Bomb Release	2-157	
Multiple Release		2-135
Multiple Release Charts, Bomb Spacing During	2-153	
Multiple Release Considerations	2-135	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Multi-Position Fuze M918		2-53
Multiple Weapons Controls and Indicators		2-4
Multiple Weapons Release System	2-3	
Multiple Weapons Station Sequence		2-7
Multiple Weapons System Control Panel	2-6	
Mutual Support	1-8	
M1A1 Fuze Extension (Daisy Cutter)		2-49
M20/20A1 Sensing Element		2-64
M117A1 GP Bomb (750 lb.)		2-179
M156	2-77	
M904E2/E3 Nose Fuze		2-48
M918 Multi-Position Fuze		2-53
M907 E1/E2 Fuze		2-61
M990 E-1/E-3/E-4 Tail Fuzes		2-57
N		
Navigation	2-79	
Navigation, DR	2-79	
Navigation, Radar	2-79	
Navigation Symbols	2-82	
Night/All Weather Visual Identification/Rendezvous	1-50	
Night Attack	2-104	
*Night LGB Delivery Tactics	2-4	
Non-Maneuvering Envelopes, AIM-7D		1-233
Non-Maneuvering Envelopes, AIM-7E-2		1-191
Non-Maneuvering Targets, AIM-9B Missile Performance Against	1-175	
Non-Maneuvering Targets, AIM-9D/G/H Missile Performance Against	1-175	
*Noise and Chaff - Pulse Doppler, Effects of	1-11	
*Noise and Chaff - Pulse, Effects of	1-11	
*Noise Jammers	1-8	
*Noise Jammers - Pulse Doppler, Effects of	1-8	
*Noise Jamming	1-16, 1-23, 1-27	1-9
*Noise Jamming Angle Track	1-20	
*Noise Jamming - Pulse, Effects of	1-8	
*Noise Techniques, Additional	1-11	
Normal Operation	2-16	
Normal Release Sequence		2-9
*North Korea Capabilities, Limitations, and Trends	5-4	
*North Vietnam Capabilities, Limitations, and Trends	5-4	
Nose Fuze, MK 347		2-47
Nose Fuze, M904E2/E3		2-48
Number of CAP Interceptors	3-19	
O		
Objectives, Engaged and Free Fighter	1-58	
Oblique Loop		1-27
Offensive Maneuvering, One Versus One	1-12	
Offensive Tactics, Loose Deuce		1-62
One-G Load Tracking	2-127	
One Mile Method Envelope		1-181
One Versus One Offensive Maneuvering	1-12	
Operation Against Surface Targets	1-216	
*Operation, AN/ALQ-51A System	5-150	
*Operation, AN/ALQ-91	5-195	
*Operation, AN/ALQ-91A	5-203	
*Operation, AN/ALQ-100 System	5-151	
*Operation, AN/APR-27 System	5-153	
*Operation, AN/APX-76A Interrogator Set	5-190	
Operation, AN/APX-76A Interrogator Set	1-157	
*Operation, RHAW Set	5-158, 5-163	
Operation, SEAM		1-184
*Operational Guidelines	5-213	
*Operations Against Anti-Ship Missiles	5-126	
*Operations Against Surface Targets	5-130	
*Operations, Intercept	5-5	
*Operation, Speech Security Unit	5-216	
Optical Sight Check, Rough	2-146	2-148
Optical Sight Unit	2-3	
Optimum Fighting Zone		1-6
Organization, Tactical	1-58	
Oval CAP	1-206	
Override Button, Armament Safety	2-3	
P		
*Panel, Antenna/Correlation Disable	5-158	
*Panel, Band Disable	5-158, 5-162	
*Panel, ECM Audio Control	5-151	
*Panel, ECM Warning Lights	5-153, 5-154, 5-158, 5-162	
*Panel (Front), ECM Warning Light	5-151	
*Panel, Integrated Control	5-150, 5-152, 5-154, 5-166	
*Panel, Interrogator Set Control	5-189	
*Panel, KY-28 Control	5-216	
*Panel, Programmer Control	5-166	
*Panel (Rear), ECM Warning Light	5-150	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*Panel, Threat Display	5-158, 5-162	
Paraflare Considerations	2-104	
Paraflare Delivery and Tactics, Zuni MK 33	2-108	
Paraflare Delivery Tactics		2-211
Paraflare Search Pattern Night Attack		2-106
Parallax Correction	2-146	
*Passive Detection	5-8	
*Passive Detection Equipment	5-8	
*Passive Detection Equipment, Capabilities, Limitations, and Trends of	5-8	
*Pat Hand Radar	5-101	
*Pave Knife Delivery Tactics	2-4	
*Pave Knife System	2-2	
*Pave Nail Delivery Tactics	2-4	
*Pave Nail System	2-2	
*Pave Way Delivery Tactics	2-4	
*Pave Way System	2-2	
*Pave Way Tactics		2-2
*Peel Group Radar	5-103	
*Peel Group Scan Sectors		5-105
Pendulum Effect	2-124	
Performance	3-10	
Performance, AIM-7	1-139	
Performance, Aircraft	1-3	
Performance Charts, Combat	1-80	
*Performance Comparison Combat Time, F-4J/MIG-21F		5-48
*Performance Comparison Conversion Time, F-4J/MIG-21F		5-47
*Performance Comparison, F-4J Versus MIG-21F ACM	5-39	
*Performance Comparison Maximum Load Factor, F-4J/MIG-21F		5-44
*Performance Comparison Maximum Turn Rate, F-4J/MIG-21F		5-45
*Performance Comparison Sustained Turn Load Factor, F-4J/MIG-21F		5-42
*Performance Comparison Sustained Turn Rates, F-4J/MIG-21F		5-43
*Performance Comparison-Unloaded Acceleration, F-4J/MIG-21F		5-41
Performance Configuration Summary		3-11
Performance Data, Flight	3-10	
*Performance, Flagon A		5-62
Performance, MQM-74A		1-241
Performance, Tactical Flight	3-10	
*Picket Ships, Radar	5-12	
Pilot Lockon Modification (PLM)	1-151	
Pilot's Briefing Form		2-99
Pipper Tracking and Wind Effect (Pitch Back), Vertical Reversal	1-21	2-132
Planning, CONLABS	2-143	
Planning Index, Mission	2-86	
Planning Profile, CONLABS		2-160
PMBR Release Procedures	2-14	
Pocket Guide	xiv, 2-151	
Pocket Guide Sight Settings, Sight Angle Charts and	2-150	
Point Detonating Nose Fuzes	2-72	
*Poke Up Gate	5-149	
Pop-Up Entry	2-125	
Positioning For AIM-7 Shot, Bogey		1-164
Post Takeoff Checks	1-8	
Powered Targets	1-238	
Practice Multiple Bomb Rack (PMBR)	2-35	
Precombat Switch Settings	1-9	
(Pre-engagement Patrolling), Radar Tactics	1-39	
*Premission Checks	5-169	
Preplanned Attacks	1-210	
Preplanned Strikes	2-86	
Preselected DC-Only Fuzes (M990 E1, E3, E4)	2-39	
*Presentations, Radar Scope		5-214
*PRF Audio	5-149	
Principles, Tactical	1-7	
*Priorities, ECM	1-15	
*Priority I (ECM)	1-15	
*Priority II (ECM)	1-15	
*Priority III (ECM)	1-15	
Procedures, AIM-7	1-229	
Procedures, AIM-9B	1-231	
Procedures, AIM-9D/G	1-236	
*Procedures, AN/ALR-45 Built-In-Test	5-163	
*Procedures and Tactics, ECCM	1-16	
Procedures, Boresight	2-145	
*Programmer Control Panel	5-166	
Prohibited Maneuvers	A-2	
*Projectile Characteristics		5-138
*Projectiles	5-138	
Proximity (VT) Fuzes	2-72	
Pulse Acquisition	1-142	
Pulse and Pulse Doppler Scope Displays		1-139
Pulse Doppler Acquisition	1-142	
*Pulse Doppler Manual Track	1-23	
Pulse Doppler Radar, Limitation of	3-4	
Pulse Doppler Search	1-140	
Pulse Doppler Track	1-145	
*Pulse Manual Track	1-23	
Pulse Radar, Limitations of	3-3	
Pulse Search	1-140	
Pulse Track	1-145	
Pure Pursuit Tracking Effect On Firing AIM-9		1-180
Pursuit, Lag	1-12	
(Pursuit), Stern Conversion	1-209	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Q		
Question Bank	C-1	
Quick Shot Requirements, AIM-7		1-169
Quick-Shot Requirements, AIM-9		1-187
R		
Radar Acquisition, AN/APG-59	1-141	
Radar Acquisition, AN/APQ-72	1-150	
Radar and Lookout, AN/AWG-10	1-39	
Radar Bombing, AN/TPQ-10 Ground Controlled	2-102	
*Radar Coverage MISCAP		5-129
Radar Detection and Track, AN/APG-59	1-136	
Radar Detection and Track, AN/APQ-72	1-147	
*Radar Equipment	5-9	
*Radar, Fansong	5-84	
*Radar Frequency Spectrum		5-147
*Radar Homing and Warning Receivers	5-155	
Radar, Limitations of Pulse	3-3	
*Radar, Low Blow	5-95	
Radar Malfunction	1-158	
Radar Navigation	2-79	
*Radar, Pat Hand	5-101	
*Radar, Peel Group	5-103	
*Radar Picket Ships	5-12	
Radar Prediction Overlay		2-80
*Radars, Airborne Intercept	5-16	
*Radar Scope Presentations		5-214
Radar Search, AN/APG-59	1-136	
Radar Search, AN/APQ-72	1-147	
*Radars, Ground Controlled Intercept	5-14	
*Radars, Height Finding	5-13	
Radar Sightings Report	1-45	
Radar/Speedgate Settling Time	1-154	
*Radar, Square Pair	5-101	
Radar Tactics	1-42	
Radar Tactics (Engaged)	1-53	
Radar Tactics (Pre-Engagement Patrolling)	1-39	
Radar Track, AN/APG-59	1-145	
Radar Track, AN/APQ-72	1-152	
Radius of Turn Chart, Instantaneous	1-84	1-90, 1-106
Raids, Low Altitude	3-6	
Raids, Medium and High Altitude	3-7	
Raids, Very High Altitude	3-8	
Range Estimation	1-189	1-189
*Range Gate Pulloff	5-149	
*Range Gate Stealers	1-11	
*Range Tracking Deception	5-146	
Rapid Relock	1-146	
Rate of Roll and Adverse Yaw	1-4	
Rate-of-Turn	3-2	
Reaction Time, Altimeter Lag and	2-127	
Rear Hemisphere Attacks	1-212, 1-220	
Reattack	1-221	1-221
*Receiver, AN/ALR-50(V) Missile Warning	5-153	
*Receiver, AN/ALR-45 Radar Homing and Warning	5-159	
*Receiving Set, AN/APR-27 Radar	5-152	
*Recommendations, Fundamental Maneuvering	5-179	
Reconnaissance, Armed	2-95	
Rectangular CAP	1-206	
Redundant Fuzing For Increased Reliability	2-42	
Reference Lines	2-145	2-145
References	2-77	
Release Airspeed Error	2-130	
Release Airspeed Error (Dive Delivery)		2-131
Release Airspeed Error (Level)		2-134
Release Altitude, Minimum	2-41	
Release Error Sensitivities and Wind Correction	2-150	
Release Height Error	2-130	
Release Height Error (Dive Delivery)		2-129
Release Height Error (Level)		2-134
Release Restrictions	2-120	
Release Sequence, Normal		2-9
Release System, CONLABS	2-18	
Release System, Multiple Weapons	2-3	
Releasing in a Bank, Effect of		2-131
Reliability Considerations, Fuze Safety and	2-41	
Relock, Rapid	1-146	
*Repeaters	1-12	
*Repeaters, Deception	5-146	
*Repeaters - Pulse Doppler, Effects of	1-12	
*Repeaters - Pulse, Effects of	1-12	
Rescap	2-101	
*Responsibility, Crew	5-169	
Restrictions, Release	2-120	
Retarded or Unretarded Delivery Option	2-42	
Reversal Charts, Heading	1-85	1-110
Reversal, High Rudder		1-28
Reversal, Low Energy	1-22	
Reversal (Pitch Back), Vertical	1-21	
RF Transmission Limitations	A-3	
*RHAW Controls and Displays	5-155, 5-162	
*RHAW Set Operation	5-158, 5-163	
*Rice Cup Height Finding Radar	5-13	
*Rock Cake Height Finding Radar	5-13	
Rocket Firing and Gun Firing (MK 4 Gun Pod)	2-154	
Rocket Firing Procedures	2-14	
Rocket Fuze Compatability Application		2-70

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Rocket Fuzes	2-72	2-71
Rocket Launcher Comp.		2-282
Rocket Motors	2-77	2-78
Rocket Pod Release From MER/TER	2-14	
Rocket Warheads	2-73	
Rocket Warheads (Sheet 1)		2-74
Rocket Warheads (Sheet 2)		2-75
Rocket Warheads (Sheet 3)		2-76
Rocketry	2-136	
Rocketry/Bombing.	2-124	
Rockeye II Impact Patterns	2-153	
Rockeye II MK 20 MOD 2 and 3		2-331
Roll Away, Defensive		1-33
Roll-Away Maneuver.		1-20
Rolling Scissors.		1-31
Rough Optical Sight Check	2-146	2-148
Run-Out Altitude	3-2	
Run-Out Fuel/Time		3-3
Run-Out Speed	3-2	
*Rus-2, Rus Type, Hi Dumbo, and Knife Rest A EW Radars	5-9	
S		
*SA-2 SAM System	5-84	
*SA-2 System Operation (Fansong B)	5-91	
*SA-2 TWS Beam Pattern		5-89
*SA-3 Intercept Envelope		5-99
*SA-3 Intercept Envelope Plan View.		5-100
*SA-3 Missile Performance		5-98
*SA-3 SAM System	5-95	
*SA-3 Scan Pattern.		5-96
*SA-4 SAM System	5-99	
*SA-5 SAM System	5-101	
*SA-6 SAM System	5-102	
*SA-N-1 SAM System.	5-102	
*SAM, Counter Tactics Against	5-184	
*SAM Guidance Modes	5-180	
*Samlet Missile		5-122
*(Samlet), SS-C-2b.	5-121	
*SAM Site Plan View		5-88
*SAM System Capabilities, Soviet		5-86
*SAM System, SA-5	5-101	
*SAM System, SA-4	5-99	
*SAM System, SA-N-1	5-102	
*SAM System, SA-6	5-102	
*SAM System, SA-3	5-95	
*SAM System, SA-2	5-84	
*SAM, Visual Evasion of	5-179	
Safe-Escape Considerations	2-120	
Safe-Escape Distance	2-41	
Safe Interval For Low Altitude Multiple Aircraft Attack	2-120	
Safe-Jettison	2-37	
Safe-Separation Time	2-41	
Safety Override Button, Armament	2-3	
Sample Problem, CONLABS	2-158	
Sample Problems and Computations	2-154	
*Scan Can AI Radar.	5-16	
*Scan Fix AI Radar	5-16	
*Scan Odd AI Radar.	5-16	
*Scan Odd Modified AI Radars	5-16	
*Scan Pattern, SA-3		5-96
*Scan Sectors, Peel Group		5-105
Scissors, Rolling		1-31
Scope	xiii	
Scope Displays, Pulse and Pulse Doppler		1-139
*Scopes, Strobe Display.	5-155, 5-162	
*Scrubber Missile		5-108
*(Scrubber), SS-N-1	5-106	
SEAM Advantages	1-182	
SEAM Airborne Procedures	1-183	
SEAM Ground Checks	1-182	
SEAM Missile, AIM-9G/H	1-182	
SEAM Operation.		1-184
(SEAM), Sidewinder Expanded Acquisition Mode.	1-181	
Search, AN/APG-59 Radar	1-136	
Search, AN/APQ-72 Radar	1-147	
Search Over Land, Low Altitude	1-150	
Search Over Water, Low Altitude	1-149	
Search, Pulse	1-140	
Search, Pulse Doppler.	1-140	
Section Defensive Zone		1-68
*Section Formation Rationale	5-171	
*Section Formations	5-171	
*Section Formations and Maneuvers	5-171	
Section Guidelines.	1-60	
*Section Maneuvers.	5-173	
*Sector Barrage Effectiveness	5-144	
*Sector Intercept Fire	5-142	5-143
Selection of Functioning Delay Options (MK 344/376).	2-43	
Selective Jettison	2-29	
Selective Missile Jettison Knob	2-24	
Semi-Manual Track, Manual and	1-153	
Sensing Element, M20/20A1		2-64
*Set, AN/APX-76A Interrogator Equipment.	5-189	
*Set Operation, RHAW	5-158, 5-163	
Settling Time, Radar/Speedgate.	1-154	
*Shaddock Missile		5-111
*(Shaddock), SS-N-3	5-109	
Shear Safe	2-39	
Side Lobe Detection		1-141
*Side Net Height Finding Radar	5-13	
Sidewinder AIM-9B Airspeed Limitations		A-25
Sidewinder Expanded Acquisition Mode (SEAM)	1-181	
Sight Angle Charts and Pocket Guide Sight Settings	2-150	
Sight Angle Computations.	2-154	
Sight Angle Corrections	2-146	2-166
Sight Angle for Multiple and Single Release		2-156

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Sightings Report, Radar	1-45	
Sightings, Visual	1-58	
Sight Unit, Optical	2-3	
*Single Airplane Evasive Maneuvers	5-170	
*Single Geometric Plane Maneuvers	5-180	
*Single Scan	1-18	
*Site Configuration		5-94
Slice Turn	1-22	
Smoke Warheads	2-77	
*Snap-Down Threshold	5-149	
Snap-Up, Acceleration and	1-220	
*SO Type Surface Search Radars	5-11	
*Soviet Air-To-Air Weapon Systems		5-20
*Soviet SAM System Capabilities	5-86	
*Soviet Semi-Automatic Air Defense System	5-7	
*Soviet Union Capabilities, Limitations, and Trends	5-1	
Specialized CAP	1-206	
Special Missions	2-101	
*Speech Security Unit Controls	5-215	
*Speech Security Unit (KY-28)	5-215	
*Speech Security Unit Operation	5-216	
*Spin Scan A AI Radar	5-16	
*Spin Scan B AI Radar	5-16	
*Spiral	5-173, 5-182	
Spiral, Defensive		1-29, 1-32
*Spiral Maneuver		5-175
Splash Zones, AIM-7		1-230
*Split-S	5-170, 5-173	
*Split-S Maneuver	5-174, 5-182	
Split-S Maneuver Charts	1-85	1-134
*Split-S/Spiral	5-172, 5-182	
*Split-S Spiral Maneuver		5-176
*Sponge Cake Height Finding Radar	5-13	
*Spoon Rest A and B EW Radar	5-9	
*Spot Jammers	1-8	
*Spurious Response ECM	1-14	
*Square Pair Radar	5-101	
*SS-C-2b (Samlet)	5-121	
*SS-N-1 (Scrubber)	5-106	
*SS-N-2 (STYX)	5-109	
*SS-N-3 (Shaddock)	5-109	
*SS-N-7	5-109	
*SS-N-7 Missile		5-113
*SS-N-9	5-114	
*SS-N-9 Missile		5-115
*SS-N-10	5-114	
*SS-N-10 Missile		5-116
*SS-N-11	5-114	
Stability Augmentation, Use of	1-4	
Stationing, CAP	3-1	
Stationing, High-Far CAP	3-24	
Stationing, High-Near CAP	3-24	
Stationing, Long Range CAP	3-25	
Stationing, Low-Far CAP	3-23	
Stationing, Low-Near CAP	3-20	
Stationing, Team	3-21	3-22
Station Selector Switch	2-6	
Station Sequence, Multiple Weapons		2-7
Status, Configuration	xvi	
Step Reset Switch	2-8	
Stern and Collision Approach Geometry		1-226
Stern Attack, VID Conversion to		1-48
Stern Conversion (Pursuit)	1-209	
Stern Conversion (Pursuit) Checkpoints		1-209
*Stone Cake Height Finding Radar	5-13	
Strafing	2-138	2-140
Strafing Down Range Travel and Altitude Loss (Sheet 1)		2-177
Strafing Down Range Travel and Altitude Loss (Sheet 2)		2-178
Strafing Down Range Travel and Altitude Loss Charts	2-149	2-177
Strafing Techniques, High Angle	2-139	
Strafing Techniques, Low Angle	2-138	
Straight-Path Tracking	2-127	
*Strength and Disposition of EW Radars	5-11	
*Strike Out GCI Radar	5-10	
Strike Force Protection Tactics	1-203	
Strike Force Tactical Formations		1-204
Strike Phase (Coarse Course Direction Phase)	1-228	
Strikes, Preplanned	2-86	
*Strobe Display Scopes	5-155, 5-162	
*Styx Missile		5-110
*(STYX), SS-N-2	5-109	
*SU-7A Fitter	5-57	5-57
*SU-9 Fishpot	5-59	
*SU-9 Fishpot B		5-59
*SU-11A Flagon A	5-60	5-61
Summary of Functioning Delay Options For Best Target Kill Probability (Typical)	2-43	
*Surface Search Radars, SO Type	5-11	
*Surface Targets, Operations Against	5-130	
*Surface Target, Two Aircraft vs		5-135
*Surface-To-Air Missiles	5-84	5-92
*Surface-To-Surface Anti-Ship Missiles	5-106	
*Surveillance Radar, Flat Face	5-10	
*Surveillance Radars, Early Warning and	5-9	
Suspension Equipment	2-29	2-30
Sustained G Turn Capabilities	1-84	1-107
SUU-40/A & -44/A		2-363
*Swept Jammers	1-8	

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Part No. Text	Illus.
*Switch, AN/ALE-29A Singles Chaff	5-167	
Switch, Bomb Control	2-21	
Switch, Center Station	2-21	
Switch, CONLABS	2-21	
Switch, Data Link Bomb	2-8	
Switch (F-4J/N), Weapons	2-6	
Switch, Guns	2-8, 2-16	
*Switch, IFF Ground Test	5-190	
Switch, Interval	2-11	
Switch, LABS Mode	2-21	
Switch, Missile Trigger	2-16	
Switch (Nose/Tail Arm Switch) Bomb Arming	2-8	
Switch or Weapons Switch (F-4B), Master Arm	2-6	
Switch Settings, Precombat	1-9	
Switch, Station Selector	2-6	
Switch, Step Reset	2-8	
Switch, Trigger	2-6	
Switch, Weapons	2-16	
Switch, Weapons Selector	2-6	
Symbols, Chart	2-81	
Symbols, Navigation		2-82
Symmetrical Flight V-N Diagrams	1-83	1-83
*System, Air Defense	5-1	
*System, AN/ALQ-51A Electronic Countermeasures	5-149	
*System, AN/ALQ-91 Countermeasures	5-153	
*System, AN/ALQ-100 Countermeasures	5-150	
*System, AN/APR-25 Warning	5-155	
System, CONLABS Release	2-18	
System, Jettison	2-23	
*System Loop-Test, AN/APX-76A	5-190	
System Malfunctions	1-158	
*System Operation, AN/ALQ-51A	5-150	
*System Operation, AN/ALQ-100	5-151	
*System Operation, AN/ALR-50	5-154	
*System Operation, AN/APR-27	5-153	
*System Operation (Fansong B), SA-2	5-91	
*System, Pave Knife	2-2	
*System, Pave Nail	2-2	
*System, Pave Way	2-2	
*System Test Procedures, AN/ALQ-51A	5-150	
*System Test Procedures, AN/ALR-50	5-154	
*System Test Procedures, AN/APR-25	5-159	
*Systems, Gun	5-137	
*Systems, Gun and Fire Control	5-137	
*Systems, Missile Guidance	5-121	
T		
Tactical Air Request Form		2-98
*Tactical Applications	5-212	
*Tactical Applications, AN/ALE-29A	5-167	
*Tactical Applications, AN/ALQ-51A	5-150	
*Tactical Applications, AN/ALQ-51A/100	5-151	
*Tactical Applications, AN/ALR-50	5-154	
*Tactical Applications, AN/ALR-45	5-163	
*Tactical Applications, AN/APR-25	5-159	
*Tactical Applications, AN/APR-27	5-153	
*Tactical Applications, KY-28	5-217	
*Tactical Applications of Maneuvers	5-182	
*Tactics Against Threat Aircraft, DECM	5-188	
Tactical Considerations	1-76	
Tactical Doctrine	1-7	
Tactical Flight Performance	3-10	
Tactical Formations, Strike Force		1-204
Tactical Manual Ballistics Tables	xiv	
Tactical Organization	1-58	
Tactical Principles	1-7	
Tactical Principles, Division	1-79	
Tactical Wing Formation		1-78
Tactical Wing (Killer)	1-78	
*Tactics (AIM-7), Two Aircraft vs Surface Target	5-134	
Tactics (All Weather), In-Trail	1-220	
Tactics and Air Intercept Control	3-23	
Tactics (Engaged), Radar	1-53	
*Tactics, F-4J vs MIG-21F	5-50	
Tactics, High Altitude	1-219	
Tactics, Loose Deuce	1-36	
Tactics, Loose Deuce Defensive		1-69
Tactics, Loose Deuce Offensive		1-62
Tactics, Medium Altitude	1-218	
*Tactics, Pave Way		2-2
Tactics, (Pre-Engagement Patrolling), Radar	1-39	
Tactics, Radar	1-42	
Tactics, Strike Force Protection	1-203	
Tail Fuze, MK 344/376		2-55
Tail Fuzes, M990 E-1/E-3/E-4		2-57
*Tall King EW Radar	5-9	
*Tall King/Side Net GCI Radar Combination	5-15	
TARCAP	1-203	
Target Acquisition Set, Visual	1-155	
Target, AQM-37A Missile		1-238
Target, BQM-34A Missile		1-239
Target Designation Considerations	2-116	
*Target Designator System, Laser	2-1	
Target Detecting Device, MK 43		2-67
Target Detection	1-136, 1-147	
Target Heading vs Closing Velocity		1-40
Target, Low Altitude/Low Velocity	1-215	

53 153

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
Target Motion, Wind and	2-130	
Target, MQM-74A Missile		1-240
Targets, Air-To-Air Missile	1-238	
Targets, High Altitude Supersonic	1-219	
Targets, Low Altitude	1-214	
Targets, Low Altitude/High Velocity	1-215	
Targets, Medium Altitude Subsonic	1-184, 1-218	
Targets, Operation Against Surface	1-216	
Targets, Powered	1-238	
Targets, Towed	1-238	
Targets, Very High Altitude Subsonic	1-220	
Target, TDU-22A/B Towed		1-242
TDU-22A/B Towed Target		1-242
Team Components	3-21	
Team Stationing	3-21	3-22
Team Stationing, E-2A/F4		3-25
Team Stationing, Visual		3-24
Terminology, Intercept		1-208
Tester, TTU-304 IR	1-186	
*Test Procedures, AN/ALQ-51A System	5-150	
*Test Procedures, AN/ALQ-51A/100 System	5-151	
*Test Procedures, AN/APR-25 System	5-159	
*Test Procedures, AN/APR-27 System	5-153	
Theory of Maneuvering	1-11	
*Thin Skin Height Finding Radar	5-13	
*Threat Decision Logic	5-149	
*Threat Display Implications, AN/ALR-45		5-160
*Threat Display Panel	5-158, 5-162	
*Threat Transponders and Mode of Interrogation		5-213
Time of Acquisition	1-141, 1-150	
*Token GCI Radar	5-10	
*Token or Cross Legs/Rice Cup GCI Radar Combination	5-15	
Total G Versus Radial G	1-81	
Towed Targets	1-238	
Track, AN/APG-59 Radar	1-145	
Track, AN/APQ-72 Radar	1-152	
Track, AN/APQ-72 Radar Detection and	1-147	
Track, Automatic	1-153	
Tracking	2-127	2-127
Tracking, Curvilinear	2-127	
Tracking, Gunsight	1-188	1-188
Tracking in Clutter Environment	1-146, 1-154	
Tracking, One-G Load	2-127	
Tracking, Straight-Path	2-127	
Tracking Techniques, Visual	1-166	
Track, Manual and Semi-Manual	1-153	
Track, Pulse	1-145	
Track, Pulse Doppler	1-145	
Trigger Switch	2-6, 2-16	
TTU-304 IR Tester	1-186	
*TU-28 Fiddler	5-65	5-66
Turn Capabilities, Sustained G	1-84	1-107
Turn, Cross		1-44
Turn, In-Place		1-43
Turns Into and Away From Wingman, Uncalled		1-41
Turn, Slice	1-22	
Turns, Loose Deuce	1-42	
*Two Aircraft vs Surface Target		5-135
*Two Aircraft vs Surface Target Tactics (AIM-7)	5-134	
*TWS Beam Pattern, SA-2		5-89
*Types and Effects of ECM	1-3	
*Types of AA Gun Fire Control	5-142	
Typical Armed Reconnaissance Tactics	2-95	
20 MM Ammo		2-352
U 53 153		
UHF Transmissions, Loose Deuce	1-59	
Uncalled Turns Into and Away From Wingman		1-41
Unplanned Attacks	1-214	
Updating the Manual	xiv	
Up-Wind Aim Point		2-154
Use of Afterburner	1-5	
Use of Flaps	1-5	
Use of Stability Augmentation	1-4	
Using the Pocket Guide		2-152
V		
Vectoring	3-4	
Vectoring, Collision	3-4	3-9
Vectoring, Lead Pursuit	3-5	3-7
Vector Phase	1-223	
*Velocity Gate Stealers	1-12	
Vertical Attack, VID to		1-49
Vertical Reversal (Pitch Back)	1-21	
Vertical Separation Attack, VID To A	1-50	
*Vertical-S	5-171	5-177
*Vertical-S, Modified	5-171	
*Vertical Weave	5-173	
Very High Altitude Raids	3-8	
Very High Altitude Subsonic Targets	1-220	
*VFR Attack	5-127	
VID Considerations	1-76	
VID Conversion to Stern Attack		1-48
VID Maneuvering	1-45	
VID to a Vertical Separation Attack		1-51
VID to Head-On Attack		1-47
VID to Vertical Attack		1-49

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

	Page No. Text	Illus.
*Visual Coverage MISCAP.		5-128
Visual Engagement	1-60, 1-163	
Visual Estimation of Range. . . .		1-189
*Visual Evasion of SAM.	5-179	
*Visual Evasion Rationale.	5-179	
Visual Identification/Rendezvous, Night/All Weather	1-50	
Visual Lookout Responsibility. . .		1-37
Visual Responsibilities, Loose Deuce.	1-60	
Visual Sightings.	1-58	
Visual Target Acquisition Set. . .	1-155	
Visual Team Stationing.		3-24
Visual Tracking Techniques . . .	1-166	
V-N Diagrams, Symmetrical Flight.	1-83	
*(Voice), Communications Jamming	1-26	
Voice Procedures, Firing Exercise		1-232
VTAS/Radar Mode Acquisition . .	1-152	
VT Elements	2-39	
VT (Proximity) Fuzes	2-73	
W		
Warhead (MK 33), Flare	2-77	
Warheads, Rocket.	2-73	
Warheads, Smoke	2-77	
Warning Lights Switch	2-16	
*Warning Lights Switch	5-158, 5-162	
Warnings, Cautions and Notes . .	xiv	
Weapon READY Light, Gun/Missile Arm Switch and	2-16	
Weapon Selection	2-36	
Weapon Select Switch and Weapon Selected Light	2-16	
*Weapon Systems, Fighter	5-17	
*Weapon Systems, Soviet Air-To-Air.		5-20
Weapons Release System, Multiple	2-3	
Weapons Selector Switch	2-6	
Weapons Switch	2-16	
Weapons Switch (F-4J/N).	2-6	
Weapons System Control Panel, Multiple.	2-6	
Weather and EMCON.	3-20	
*Weave, Horizontal.	5-173	
*Weave, Vertical.	5-173	
Weight Limitations	A-2	
Weight Table, Drag Index and. . .	A-2	
Wind and Target Motion	2-130	
Wind Correction Computations . .	2-154	
Wind Correction, Release Error Sensitivities and	2-150	
Wind Effect, Pipper Tracking and .		2-132
Wind Effects During Tracking. . .	2-130	
Wing Tank Pylon Adapter (Outboard MER/TER Adapter) . . .	2-34	
Wing Tank Pylon (Outboard) . . .	2-34	
Wording	xiv	
Y		
*YAK-28 Firebar.	5-64	5-65
Your Responsibility	xiv	
Yo-Yo, High		1-13
Yo-Yo, Low		1-17
Z		
Zuni MK 33 Para-Flare Delivery and Tactics	2-108	

53 153

* Refer to Secret Supplement, NAVAIR 01-245FDB-1T(A)

☆U.S. GOVERNMENT PRINTING OFFICE: 1972—769-694/107